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Preface

Agricultural Finance Review (AFR) provides a forum for research and discussion of issues in agricultural finance. This annual publication contains articles contributed by scholars in the field and refereed by peers.

Volume 43 was the first to be published at Cornell University. The previous forty-two volumes were published by the United States Department of Agriculture. *AFR* was begun in 1938 by Norman J. Wall and Fred L. Garlock whose professional careers helped shape early agricultural finance research. Professional interest in agricultural finance has continued to grow over the years involving more people and a greater diversity in research topics, methods of analysis, and degree of sophistication. We are pleased to be part of that continuing development. We invite your suggestions for improvement.

The effectiveness of this publication depends on its support by agricultural finance professionals. Your support has grown each year in terms of submissions and reviews of manuscripts. We especially express thanks to those reviewers listed below. Grateful appreciation is also expressed to the Economic Research Service, USDA, and to the W. I. Myers endowment for partial financial support.

Starting July 1, Eddy LaDue will assume the duties of editor while John Brake is on sabbatical leave at Purdue University.

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Farm Real Estate Lending by Commercial Banks

Paul N. Ellinger, Peter J. Barry, and Michael A. Mazzocco

Abstract

Commercial banks experienced increases in farm real estate loan volume in the mid-1980s and in market shares of farm debt while other lenders were experiencing declines. This article presents results from a survey of midwestern commercial banks about their historical and anticipated farm real estate lending practices and policies. The results indicate the growth in farm real estate loans is dominated by purchases of farm real estate. The heavy reliance by responding banks, especially smaller ones, on fixed-rate loans with short maturities and balloon payments may represent a tradeoff between a reduction in the bank's interest-rate risk and increases in a borrower's credit risk.

Key words: agricultural banks, farm real estate lending, loan pricing, credit evaluation, survey.

Agricultural lending by commercial banks in the U.S. has traditionally responded to the short- and intermediate-term financing needs of agricultural producers. Longer-term real estate lending was mostly left to Federal Land Banks, life insurance companies, and sellers of farmland because of the unattractive liquidity and risk characteristics of these types of loans for depository institutions. However, during the 1980s, the level and market share of farm real estate debt held by commercial banks increased substantially while the market share for the Farm Credit System (FCS) decreased after 1984. The market share of farm real estate debt held by the FCS increased from 19% in 1960 to over 44% in 1984 (USDA). During this same time period, the market share for commercial banks fell from 13.5% to below 10%. In 1984 the trend reversed and the FCS began to decline in market share while commercial banks increased. Loans secured by farm real estate at commercial banks increased from $8.392 billion in 1982 to $15.417 billion in 1988, and banks' market share increased from a low of 7.6% of total farm real estate debt in 1982 to 18.6% in 1988. At the same time, the levels and market shares of farm real estate debt held by the FCS and individuals declined considerably, the debt outstanding from life insurance companies declined although their share remained relatively constant, and the debt levels and market shares of the Farmers Home Administration increased slightly.

These recent changes in farm real estate lending are likely attributable to a combination of factors in agriculture, capital markets, and financial institutions. In agriculture, the severe financial stresses of the 1980s brought financial hardship to all lenders, especially Federal Land Banks due to their long-term, specialized lending to agriculture. Institutional responses included

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more-conservative lending practices, higher interest rates, and downsizing of loan portfolios, all of which contributed to the restructuring of the farm real estate lending market. The profitability of agricultural banks came under substantial downward pressure, although compensating factors were the relatively high liquidity of agricultural banks following the downturn in high loan-to-deposit ratios of the 1970s, the slowdown in farm loan demand, and the shorter-term nature of bank lending which allowed more rapid portfolio adjustments than for long-term lenders. Thus, many agricultural banks were well positioned to selectively increase their farm real estate lending as the sectoral stress continued.

Financial deregulation and structural changes of depository institutions during the 1980s also increased competitiveness in banking markets, enhanced lending and risk-bearing capacities, and heightened the interest among agricultural banks in offering a full range of short-, intermediate-, and long-term credit services to farm borrowers (American Bankers Association). Indeed, the banking industry played a major role in developing and promoting the concept of a secondary market for farm real estate loans, as reflected by the creation of the Federal Agricultural Mortgage Corporation (Farmer Mac) in the Agricultural Credit Act of 1987. All of these factors, together with the observed changes in farm real estate debt, suggest that long-term changes in the structure of farm real estate lending are occurring.

In light of these developments, a timely and comprehensive information base that enumerates commercial banks' policies and practices regarding farm real estate lending is needed. Accordingly, the purpose of this study is to report and analyze the results of a mail survey of midwestern banks about their present and anticipated future involvement in farm real estate lending. The specific goals of the survey are to explain the growth in commercial banks' farm real estate loans, determine the borrowers' purposes for acquiring these funds, identify the pricing policies and credit-evaluation procedures, and assess the future goals of agricultural banks in farm real estate lending, including the anticipated use of the new secondary market. The survey responses are evaluated according to the banks' agricultural dependence, size, and legal structure under the premise that larger, less-specialized banks with more complex legal structures would have greater capacities to provide farm loans with more-extensive pricing arrangements and evaluation procedures (Barry and Calvert).

Survey Development and Responses

The geographical scope of the survey encompasses the five-state region of Arkansas, Illinois, Indiana, Iowa, and Missouri.[1] Agriculture is a major economic sector in each of the states and while the commodities produced are similar, the systems of production and levels of productivity exhibit considerable diversity. Moreover, the regional approach will provide information on a wide range of bank structures.

Farm real estate debt held by commercial banks in this five-state region comprised 29% of all farm real estate debt held by commercial banks in the United States at the end of 1988. The market share of farm real estate debt held by commercial banks in this region increased from 8.5% in 1982 to 23.6% in 1988 (U.S. Department of Agriculture). Moreover, the volume of farm real estate debt held by commercial banks in this region increased 101% over this time period, while the farm real estate debt held by all lenders in the region declined by 29%.

The procedure was to survey all "agricultural banks" in the five-state region. An agricultural bank was defined to have agricultural loans greater than $2.5 million or a ratio of agricultural loans to total loans that exceeded 0.25 at the end of 1987.[2] The dual criteria of a loan-concentration ratio

[1]The surveys were also mailed to agricultural banks in Texas. Results are similar but not reported here due to the dissimilarities in agricultural enterprises, geographical region, and banking laws.

[2]The Call and Income Reports include two categories of loans that relate to agriculture: "loans secured by farm real estate" and "loans to finance agricultural production and other loans to farmers." Agricultural loans are defined as the sum of these two categories.

and loan volume were used to include larger commercial banks with a large volume of agricultural loans but not necessarily a high concentration in agricultural lending (Barry and Calvert). The 1,625 banks in the region that met these criteria held 92% of all agricultural loans from commercial banks in the region and 89% of all "loans secured by farm real estate" at year end 1987 (Board of Governors of the Federal Reserve).

The survey questionnaire contains five parts: (1) introduction, (2) current farm real estate lending, (3) farm real estate lending in 1988, (4) future farm real estate lending, and (5) secondary-market issues.[3] The introduction elicits descriptive information about the bank's legal structure, market size, and types of farming in its loan market, number of borrowers and farm real estate loans, and use of a written policy for farm real estate lending. Part 2 of the questionnaire addresses the bank's current practices and policies for farm real estate lending. Included is information about the following:

- General policies for fixed- and variable-rate loans
- Frequency, limits, and basis of rate adjustments
- The range of interest rates on fixed- and variable-rate loans
- Maturity distributions of farm real estate loans
- The evaluation of borrower risk and use of risk-adjusted loan pricing
- Downpayment requirements
- Borrowers' purposes for acquiring funds that are secured by farm real estate
- Estimates of farm real estate loans reported in FDIC Call Report categories other than "loans secured by farm real estate"

Questions in Part 3 focus on the characteristics of farm real estate lending in 1988 in order to identify whether any significant and recent changes are occurring in the terms and purposes of these loans relative to the previous three to five years. The remaining parts of the survey address the bank's future goals in farm real estate lending, activities of competing lenders, and anticipated use of the secondary loan market.

The surveys were mailed to the 1,625 banks on April 13, 1989, with a follow-up reminder on May 12. By June 15, 695 usable responses (43% response rate) were received. The responding banks hold 44% of all loans secured by farm real estate held by all commercial banks in the five-state region.

Survey Results

The results presented include descriptive characteristics of the responding agricultural banks and details on the purposes of loans secured by farm real estate. The pricing strategies, credit terms, credit-evaluation procedures on farm real estate loans, along with the future goals for farm real estate lending and secondary-market activity are also discussed.

Descriptive Characteristics

The average bank responding to the survey held $81.6 million in assets, with bank size ranging from $5 million to $469 million. The size distribution was heavily concentrated among small banks. Over 60% of the banks responding to the survey had assets of less than $50 million, while 85% of the responding banks had assets of less than $100 million. The banks had an average of $2.9 million of farm real estate debt outstanding (ranging from $0 to $18 million), 136 farm borrowers (real estate and non–real estate), 50 farm real estate loans, and an average farm real estate loan size of $78,400. The average farm real estate loan size increased from $53,560 for banks with assets less than $25 million to $180,312 for banks with assets greater than $300 million. The average farm real estate loan sizes for banks with assets from $25 million to $100 million and $100 million to $300

[3]An informal advisory panel consisting of representatives from the Illinois and American Bankers Associations, St. Louis Farm Credit Banks, Federal Reserve Bank of Chicago, and Purdue University along with ten agricultural lenders assisted in the development and testing of the survey. A copy of the questionnaire is available upon request.

million were $76,810 and $100,900, respectively.[4]

The average agricultural loan ratio of responding banks was 0.35. Using the entire survey sample as the population, the hypotheses that the mean asset size and agricultural loan ratio for responding banks are different from the population means ($96.7 million and 34.2%, respectively) could not be rejected at the 95% confidence level. Using the same test, the average amount of loans secured by farm real estate for responding banks ($2.9 million) was significantly higher than the population mean of $2.5 million.

Thirty-one percent of the banks were affiliated with a multibank holding company (MBHC), while 45% were affiliated with a single-bank holding company, and 23% were nonaffiliate banks. Ninety-three percent of the banks regarded their loan market as local, with an average radius of twenty-six miles. Six percent of the responding banks operated in a regional market within a state, 1% had a statewide market, and only 0.3% indicated a national market. Cash-grain farms were ranked as the most important type of farming for their farm borrowers by 83% of the banks, while swine farms were ranked second in importance by 57% of the banks. In general, survey responses were dominated by smaller, community-oriented banks that were heavily involved in farm lending.

[4]The mean average loan size for each asset size class was significantly different from the mean average loan size of the other size classes at the 95% confidence level.

Borrowers' Purposes of Acquired Funds Secured by Farm Real Estate

Commercial banks are required by law to report income and balance-sheet information on a quarterly basis. This procedure involves reporting different types of loans in separate categories. "Loans secured by farm real estate" is one of these categories. However, using the source of security as the basis for classification provides no information about the purposes of the loans. The loan proceeds could be used for a variety of purposes, including financing the purchase of farm real estate and related improvements, refinancing existing loans, and for non–real estate lending purposes. Because no recently published data are available about the purposes of farm real estate loans, the bankers were asked to estimate the distribution of their farm real estate debt over the range of loan purposes (shown in Table 1).

Table 1. Purposes of Loans Secured by Farm Real Estate

	Mean Response All Banks	
	Equal Weighting	Weighted by Farm Real Estate Lending Volume
The dollar volume of loans reported as "loans secured by farm real-estate" was distributed among the following loan purposes:	*Percent of "Loans Secured by Farm Real Estate"*[1]	
For the Purchase and Improvements of:		
Land	52	50
Buildings	9	8
Purchases of Machinery, Equipment, and Other Farm Items	5	4
Purchases of Nonfarm Items	1	1
Refinancing of:		
Long-term loans, this bank	7	7
Long-term loans, other bank	4	4
Long-term loans, Farm Credit System	13	16
Agricultural production loans	9	8
Other loans	1	1

[1]Totals may not add to 100% due to rounding.

The averages for the banks responding to the survey indicate that 61% of banks' loans secured by farm real estate were made for purposes of purchasing or improving farmland or buildings. About 34% of the loans secured by farm real estate were used for various kinds of refinancing—11% for refinancing of loans by the respondent bank or other banks, 13% for refinancing of FCS loans, and 9% for refinancing of agricultural production loans. Another approach to measuring the purposes of loans secured by farm real estate is to weight the responses according to the amount of farm real estate debt outstanding from the respective banks. Using this calculation procedure, 58% of the banks' farm real estate loans were made for purposes of purchasing or improving land or buildings, while 36% of the banks' loans secured by farm real estate were used for refinancing various types of debt.

These loan-purpose results provide some interesting contrasts to similar data attained in a 1981 survey of Illinois banks by Calvert and Barry. The 1981 survey of weighted responses from 305 Illinois banks indicated that 72% of banks' loans secured by farm real estate were for purposes of purchasing or improving farmland or buildings. About 16% of these loans were used for various kinds of refinancing, 8% of farm real estate loans were used for non–real estate purposes, and 4% were used for nonfarm purposes. The higher incidence of refinancing in the 1989 results was consistent with the financial stresses experienced by farmers and lenders in the 1980s.[5]

The only explicit relationship among bank size, legal structure, or agricultural dependence, and purpose of farm real estate loans was that the proportion of loans used for the refinancing of long-term FCS loans increased as bank size increased. Banks with total assets less than $25 million reported that 9% of the loans secured by farm real estate were used for refinancing long-term FCS loans, while banks with assets greater than $300 million reported 19%. Banks with assets between $25 million and $50 million, $50 million and $100 million, and $100 million and $300 million reported 13%, 15%, and 19%, respectively.[6] This relationship indicates that a higher proportion of the borrowers that refinanced FCS loans selected larger banks. This is likely due to loan limits of small banks or to the smaller banks' inability to offer the flexible loan terms extended at larger banks.

The 1989 survey also asked bankers to indicate whether or not they held loans to finance the purchase of farm real estate that were not secured by farm real estate and thus not reported as loans secured by farm real estate. Seventeen percent of the banks reported such loans, which totaled about 4.1% of the sum of these loans reported elsewhere plus loans secured by farm real estate. About two-thirds of these additional farm real estate loans were reported as "production and other loans to farmers," while the rest were distributed over several Call Report categories.

Fixed- and Variable-Rate Pricing on Farm Real Estate Loans

Banks use various loan pricing strategies to reduce their exposure to interest-rate risk. These strategies include offering fixed-rate loans with short maturities or variable-rate loans tied to an index. A myriad of variable-rate loan packages has developed from these strategies.

Survey results reported in Table 2 indicate the relative use of fixed- and variable-rate loans. Sixty-one percent of the banks offered fixed-rate loans and 67% of the banks offered variable-rate loans, while 31% of the responding banks offered both fixed- and variable-rate farm real estate loans. The responses exhibit a tendency for smaller banks to offer a higher proportion of fixed-rate loans while larger banks offered a higher proportion of variable-rate loans. Fixed-rate loans were offered by 68% of the banks with assets less than $50 million, 42%

[5]The respondents to the 1989 survey also were asked to report farm real estate lending in 1988. On average, 70% of the new loans completed were used for the purchase of farm real estate while 27% were used to refinance long-term loans and previous operating losses. These results indicate a decreasing proportion of new loans secured by farm real estate is being used for refinancing purposes.

[6]The mean value for banks with assets less than $25 million is significantly less than for each of the other bank size categories at the 95% confidence level.

Table 2. Fixed- and Variable-Rate Pricing on Farm Real Estate Loans, Classified by Bank Size and Structure

	Use of Fixed Interest Rates	Use of Variable Interest Rates	Use of Both Fixed & Variable	Percent Variable-Rate Loans	Fixed Rate		Variable Rate	
					Minimum Offered	Maximum Offered	Minimum Offered	Maximum Offered
	Percent of Banks			*Percent of Farm Real Estate Loans*	*Interest Rate, %*			
All Responses	61	67	31	43	11.42	12.29	11.25	12.57
Bank Size, Assets								
Less than $25M (a)	68[cd1]	57[cde]	27[e]	35[cde]	11.34[c]	12.27[d]	11.15[e]	12.48[e]
$25M to $50M (b)	69[d]	64[cd]	33[e]	37[cde]	11.43	12.23[d]	11.16[e]	12.40[de]
$50M to $100M (c)	53[a]	74[abd]	34	50[abd]	11.52[a]	12.28	11.33	12.58[e]
$100M to $300M (d)	42[b]	86[abc]	34	67[abc]	11.44	12.58[ab]	11.37	12.81[ab]
Greater than $300M (e)	58	79	53[ab]	55[ab]	11.48	12.64	11.69[ab]	13.73[abcd]
Bank Structure								
NO&SBHC	66	63	31	38	11.40	12.29	11.20	12.48
MBHC	52[2] [2][3]	78[2] [2]	35	54[2] [2]	11.47	12.31	11.35[2]	12.74[2]

[1]Letters indicate mean significant difference (90% level) between banks of different size classes. Example: "cd" in row (a) (less than $25 million) indicates that the mean value in row (a) (less than $25 million) is significantly different from the mean values in rows (c) ($50 million to $100 million) and (d) ($100 million to $300 million) at the 90% confidence level.

[2]Paired mean values or proportions of banks are significantly different between NO&SBHC and MBHC at the 90% confidence level.

[3]Bracketed numbers indicate the size categories in which the NO&SBHC and MBHC mean values are significantly different at the 90% confidence level. Size categories: 1 = less than $25M; 2 = $25M to $50M; 3 = $50M to $100M; 4 = $100M to $300M; 5 = greater than $300M. Example: A "[2]" indicates that the mean values for NO&SBHC and MBHC are significantly different from each other in size class 2 ($25 million to $50 million) at the 90% confidence level.

of banks with assets between $100 million and $300 million, and 58% of banks with assets greater than $300 million. In contrast, about 60% of banks with assets less than $50 million offered variable-rate loans, while 86% of banks with assets between $100 million and $300 million, and 79% of banks with assets greater than $300 million offered variable-rate loans. The incidence of banks that offered both fixed- and variable-rate loans also increased as bank size increased. In addition, results indicate that banks affiliated with a multibank holding company were more likely to offer variable-rate loans, while a higher proportion of banks not affiliated with a multibank holding company (NO&SBHC) offered fixed-rate loans.

On average, 43% of a bank's portfolio of farm real estate loans was variable rate. The average proportion of variable-rate farm real estate loans was 52% when weighting the responses by the amount of farm real estate loans.[7] The proportion of banks that offer variable-rate loans was lower than 1988 results on agricultural operating loans reported by Walraven and Rosine (61%). Their results also indicate a tendency for larger banks to have a higher proportion of loans that were variable rate.[8]

The interest rate results in Table 2 indicate that the average minimum rate offered for fixed-rate farm real estate loans was 11.42%, while the average maximum rate was 12.29%, or an average differential of 0.87%. Generally, the average minimum and maximum fixed interest rates offered at commercial banks exhibited a slight increase as bank size increased. The 1.32 percentage point range of interest rates on variable-rate farm real estate loans, based on an average minimum rate of 11.25% and maximum of 12.57%, was larger than the range for fixed-rate loans. The average

[7]An average of 51% of the *new* loans completed (funds were dispersed) in 1988 were variable rate.

[8]Logistic regression was also used to measure the relationships between the likelihood of offering fixed- and/or variable-rate loans with bank size and legal structure. Instead of discrete size classes, this method uses measurements of bank size in a continuous framework. Even though this technique provided additional information, because both bank size and bank structure are included as independent variables, the results do not provide any additional or conflicting information relative to the analysis-of-variance results. The logistic results and the marginal probability effects are available from the authors.

minimum and maximum rates charged on variable-rate farm real estate loans also increased as bank size increased. The average level of minimum and maximum rates for fixed-rate loans exceeded these levels for variable-rate loans by 0.293% and 0.066%, respectively, for all banks that offer both fixed- and variable-rate farm real estate loans.

The results reported earlier indicate that smaller banks not affiliated with a multibank holding company were more likely to offer fixed-rate farm real estate loans, while larger banks and banks affiliated with a multibank holding company tended to offer variable-rate loans. There was also a slightly higher probability of MBHCs and large banks offering both fixed- and variable-rate loans. Table 3 shows additional characteristics of banks that offer: (1) only fixed-rate loans, (2) only variable-rate loans, or (3) both fixed- and variable-rate loans. The average asset size for banks offering only fixed-rate loans was $42 million, the average asset size for banks offering only variable-rate loans was $77 million, and the average for banks that offer both fixed- and variable-rate farm real estate loans was $87 million. Eighty-one percent of banks offering only fixed-rate loans were not affiliated with a multibank holding company while 39% and 34% of banks offering only variable-rate and both fixed- and variable-rate loans, respectively, were affiliated with a multibank holding company.

The agricultural loan ratio was highest for banks offering fixed-rate loans (40.2%). This was expected since smaller banks generally have higher agricultural loan ratios. The agricultural loan ratio was higher for banks offering both fixed-rate and variable-rate loans than for banks only offering variable-rate loans. In addition, the farm real estate loan ratio (loans secured by farm real estate divided by total loans) was highest for banks offering both fixed- and variable-rate loans. These observations, combined with the previous result that banks offering both fixed- and variable-rate loans had the highest average asset size, indicate that larger banks with a higher dependence on agriculture were more likely to offer both fixed- and variable-rate loans.

Loan Maturity

Table 4 reports the maturity distribution of all farm real estate loans along with the downpayment patterns for farm real estate loans. On average, over 60% of each bank's farm real estate loan volume had an original maturity of five years or less, with a balloon payment due at the end of the loan

Table 3. Characteristics of Commercial Banks that Offer Only Fixed-Rate, Only Variable-Rate, and Combinations of Fixed- and Variable-Rate Farm Real Estate Loans

	Fixed Rate Only	Variable Rate Only	Both Fixed & Variable Rate
		Mean Values	
	(a)	(b)	(c)
Total Assets, $ Million	42.1	76.8	87.0
	bc[1]	a	a
Agricultural Loan Ratio, %	40.2	31.8	36.2
	bc	ac	ab
Farm Real Estate Loan Ratio, %	12.9	13.3	13.6
Percent of Banks Affiliated with a Multibank Holding Company	19.0	39.3	34.3
	bc	a	b

[1]Letters indicate mean significant difference (90% level) between banks that offer fixed-rate and/or variable-rate farm real estate loans. Example: "bc" in column (a) (fixed rate only) indicates that the mean value in column (a) (fixed rate only) is significantly different from the mean values in columns (b) (variable rate only) and (c) (both fixed and variable rate) at the 90% confidence level.

contract. Only 10% of the farm real estate loan volume had a six- to ten-year original maturity, while 26% were written for longer than ten years.[9] Larger banks indicated a higher concentration of loan volume with larger maturities. Thus, in combination with the higher incidence of fixed-rate loans at smaller banks, it appears that banks are tending to build repricing opportunities into fixed-rate lending by using relatively short maturities (i.e., five years or less) with loan renewals at the end of the loan contract. The bankers were not asked whether the repayment requirements for loan principal reflect an amortization period that exceeds the loan maturity, but this practice has been frequently observed.[10]

Variable-rate loans should allow the banks to offer longer maturities while still passing the interest-rate risk on to the borrowers. Accordingly, a correlation test between the proportion of variable-rate loans in the portfolio and the maturity distribution was performed to test this possible relationship. Indications are that the higher the proportion of variable-rate farm real estate loans (VRP), the higher the proportion of eleven- to twenty-year maturing loans (11-20YL) and the lower the proportion of zero to five-year balloon-payment (0-5B) loans. The Pearson product moment correlation coefficient between VRP and 11-20YL was 0.3494 (p value < 0.0001), and -0.4187 (p value < 0.0001) between VRP and 0-5B. The results, when weighting the proportions by agricultural real estate volume, were 0.3982 and -0.4438, respectively.

The respondents that offered fixed-rate farm real estate loans were asked to report the maximum maturity offered and the corresponding base interest rate charged. Over 75% of the banks indicated a maximum maturity of fixed-rate farm real estate loans of five years or less. Only 3.9% of the banks offering fixed-rate loans extended loans with maturities greater than twenty years. The average interest rate offered increased from 11.64% for loans with maturities of five years or less to

[9]These figures represent the unweighted averages. The maturity distribution of farms weighted by the amount of farm real estate debt outstanding is: 0 to 5 years, 58%; 6 to 10 years, 9%; and greater than 10 years, 31%.

[10]Based on personal conversations with various lenders.

Table 4. Maturity Distribution and Downpayment Patterns for Agricultural Banks, Classified by Bank Size and Structure

	Years to Maturity					Downpayment Pattern Equity to Appraised Land Value			
	0–5								
	With Balloon	Without Balloon	6–10	11–20	Greater than 20	Less than 10%	11%–25%	26%–50%	Greater than 50%
	Percent of Farm Real Estate Loans								
All Responses	61	3	10	24	2	2	44	50	4
Bank Size, Assets									
Less than $25M (a)	64[cd1]	4	13[b]	18[cd]	1	3	50[bcd]	43[cd]	3[c]
$25M to $50M (b)	69[cd]	3	8[a]	18[cd]	2	3	44[a]	49	4
$50M to $100M (c)	49[ab]	4[d]	10	34[ab]	2	1	38[a]	55[a]	5[a]
$100M to $300M (d)	53[ab]	1[c]	10	34[ab]	2	3	39[a]	55[a]	3
Greater than $300M (e)	55	5	13	28	0	3	42	52	3
Bank Structure									
NO&SBHC	63	3	10	23	1	2	45	48	4
MBHC	55[2]	4	11 [1,2,3][3]	28	2 [2]	3[2]	41	52	3

[1]Letters indicate mean significant difference (90% level) between banks of different size classes. Example: "cd" in row (a) (less than $25 million) indicates that the mean value in row (a) (less than $25 million) is significantly different from the mean values in rows (c) ($50 million to $100 million) and (d) ($100 million to $300 million) at the 90% confidence level.

[2]Paired mean values or proportions of banks are significantly different between NO&SBHC and MBHC at the 90% confidence level.

[3]Bracketed numbers indicate the size categories in which the NO&SBHC and MBHC mean values are significantly different at the 90% confidence level. Size categories: 1 = less than $25M; 2 = $25M to $50M; 3 = $50M to $100M; 4 = $100M to $300M; 5 = greater than $300M. Example: A "[1,2,3]" indicates that the mean values for NO&SBHC and MBHC are significantly different from each other in size classes 1 (less than $25 million), 2 ($25 million to $50 million), and 3 ($50 million to $100 million) at the 90% confidence level.

12.05% for loans with maturities greater than twenty years.[11]

Downpayments on Farm Real Estate Loans

The downpayment requirement, which is typically used to protect the lender from collateral devaluation, is another policy variable that must be determined at each bank. A minimum downpayment criterion had been established for the purchase of farm real estate by 96% of the banks with an average *minimum* ratio of equity to appraised land value of 27%. The distribution of downpayments by borrowers over the past three years ranged from 11% to 25% of appraised value for 44% of the banks, and from 26% to 50% of appraised value for 50% of the banks. As shown in Table 4, larger banks (i.e., above $50 million in assets) on average tended to have a higher proportion of farm real estate loans with higher downpayments.

Variable-Rate Repricing Procedures on Farm Real Estate Loans

Table 5 reports the survey results describing repricing procedures and determinants of the base rate used for variable-rate farm real estate loans. The frequency of rate adjustment on variable-rate loans was dominated by annual adjustments, with larger banks and banks affiliated with multibank holding companies indicating more frequent reviews. While not reported in the table, the base interest rate on existing variable-rate farm real estate loans was changed an average of 3.11 times during 1988 for all banks, 4.27 times for the banks with assets greater than $300 million, and 3.17 times for the banks with assets less than $25 million. Thirty percent of the banks had a limit or cap on the size of rate adjustment in one period. The average cap for these banks was 2.10%.

Forty-nine percent of the banks responding to the survey indicated that the base for

[11]The responses to many of the survey questions, along with any inferences drawn from the survey, are based on the interest-rate environment on March 31, 1989. The interest rate on one-year U.S. Treasury notes and bonds was 9.71%. U.S. Treasury notes and bonds peaked at two years to maturity (9.81%) and steadily declined to 30 years to maturity (9.17%). The federal funds and prime rate on March 31, 1989 were 9.88% and 11.50%, respectively (Board of Governors of the Federal Reserve System 1989).

Table 5. Repricing Horizon and Determinants of Base Rate for Variable-Rate Farm Real Estate Loans, Classified by Bank Size and Structure

	Repricing Horizon					Base-Rate Determinants		
	Weekly or Shorter[1]	Monthly to Quarterly	Semi-annually	Annually	Use of Rate Caps	Cost of Funds[2]	Index Rates	Competitive Rates
	Percent of Banks							
All Responses	13	23	12	58	30	32	49	38
Bank Size, Assets								
Less than $25M (a)	16[be3]	25[e]	11	56[e]	29	36[e]	46[e]	29[b]
$25M to $50M (b)	7[ae]	19	13	62[e]	31	38[e]	46[e]	39[ace]
$50M to $100M (c)	12[e]	21	11	58[e]	35	43[e]	48[e]	23[bd]
$100M to $300M (d)	13[e]	17	17	63[e]	25	40[e]	52[e]	38[ce]
Greater than $300M (e)	40[abcd]	7[a]	7	33[abcd]	20	7[abcd]	79[abcd]	14[bd]
Bank Structure								
NO&SBHC	10	22	11	57	32	42	43	33
MBHC	16[4] [1,4][5]	18	15 [2]	61 [1]	28	32[4]	67[4] [1]	30

[1]Banks could indicate more than one repricing horizon.

[2]Banks could indicate more than one determinant of the base interest rate used.

[3]Letters indicate mean significant difference (90% level) between banks of different size classes. Example: "be" in row (a) (less than $25 million) indicates that the mean value in row (a) (less than $25 million) is significantly different from the mean values in rows (b) ($25 million to $50 million) and (e) (greater than $300 million) at the 90% confidence level.

[4]Paired mean values or proportions of banks are significantly different between NO&SBHC and MBHC at the 90% confidence level.

[5]Bracketed numbers indicate the size categories in which the NO&SBHC and MBHC mean values are significantly different at the 90% confidence level. Size categories: 1 = less than $25M; 2 = $25M to $50M; 3 = $50M to $100M; 4 = $100M to $300M; 5 = greater than $300M. Example: A "[1,4]" indicates that the mean values for NO&SBHC and MBHC are significantly different from each other in size classes 1 (less than $25 million) and 4 ($100 million to $300 million) at the 90% confidence level.

variable-rate loans was determined by a spread or percentage markup over a national index rate (i.e., prime rate, treasury bill rate). Moreover, 32% use cost of funds as a base rate, while 38% use competitive rates to price variable-rate farm real estate loans. The sum of the percentages exceeds 100%, indicating that banks tend to use multiple sources of information in their loan pricing. Larger banks and banks affiliated with a multibank holding company had a higher proportion of banks that use index rates as a base rate for farm real estate loans. The average minimum rate offered for farm real estate loans for banks using competitive rates was 11.11%. This rate was lower than the average minimum rates offered by banks using cost of funds (11.31%) or index rates (11.30%).

Credit Evaluation and Pricing Procedures

The growing use of risk-adjusted loan pricing, especially in larger banks, was shown by the survey results in Table 6. Sixty-two percent of banks with assets less than $25 million and 58% of banks with assets between $25 million and $50 million use risk-adjusted pricing, while 78% and 88% of banks with assets between $100 million and $300 million, and greater than $300 million, respectively, use risk-adjusted pricing. A higher proportion of banks affiliated with a multibank holding company use risk-adjusted pricing. The 1984 survey by Schmiesing, Edelman, Swinson, and Kolmer reported 69% of the responding banks in South Dakota used differential pricing on agricultural operating loans, while the 1981 national survey of agricultural banks by Barry and Calvert indicated that differential loan pricing among farm customers was practiced by 47% of the banks. Since the 1989 survey focused only on farm real estate loans, it is likely that the use of differential pricing for all agricultural loans is even higher than the 64% figure obtained from the survey. Moreover, the use of the practice clearly has increased during the 1980s.

The utilization of risk-adjusted pricing affects the various interest rates offered by each bank. The average minimum fixed rate offered by banks not using risk-adjusted pricing was 11.41%, while the same minimum rate offered by banks using risk-based pricing was 11.45%, or no significant difference at the 95% confidence level. In contrast, the average maximum rate offered on fixed-rate loans for banks not using risk-adjusted pricing was 11.92%,

Table 6. Pricing Procedures and Credit-Evaluation Procedures for Farm Real Estate Loans, Classified by Bank Size and Structure

	Use of Risk-Adjusted Pricing	Use of Formal Credit Scoring	Solvency	Profitability	Debt-Servicing Capacity	Liquidity	Repayment History	Collateral	Other
	Percent of Banks		*Proportional Weights Given to Borrower's Credit Factors*						
All Responses	64	27	11	17	23	9	12	26	1
Bank Size, Assets									
Less than $25M (a)	62[de1]	24	12	14[cde]	24	9	12	28[de]	1
$25M to $50M (b)	58[cde]	27	11	16[c]	24[c]	8[ce]	12	27[d]	2
$50M to $100M (c)	67[bde]	25	11	20[ab]	20[bd]	10[b]	12	26	1
$100M to $300M (d)	78[abc]	31	10	19[a]	27[c]	8[e]	13	22[ab]	1
Greater than $300M (e)	88[abc]	39	15	21[a]	20	13[bd]	10	21[a]	0
Bank Structure									
NO&SBHC	61	25	11	16	23	8	13	27	1
MBHC	72[2]	31[2]	11	18	23	9	11[2] [4][3]	26 [3]	2

[1]Letters indicate mean significant difference (90% level) between banks of different size classes. Example: "de" in row (a) (less than $25 million) indicates that the mean value in row (a) (less than $25 million) is significantly different from the mean values in rows (d) ($100 million to $300 million) and (e) (greater than $300 million) at the 90% confidence level.

[2]Paired mean values or proportions of banks are significantly different between NO&SBHC and MBHC at the 90% confidence level.

[3]Bracketed numbers indicate the size categories in which the NO&SBHC and MBHC mean values are significantly different at the 90% confidence level. Size categories: 1 = less than $25M; 2 = $25M to $50M; 3 = $50M to $100M; 4 = $100M to $300M; 5 = greater than $300M. Example: A "[4]" indicates that the mean values for NO&SBHC and MBHC are significantly different from each other in size class 4 ($100 million to $300 million) at the 90% confidence level.

while the maximum rate offered for banks utilizing risk-adjusted pricing was 12.52%. The average values for the maximum rates were significantly different from each other at the 95% confidence level.[12] These results of a relatively insignificant difference between minimum rates offered among banks utilizing and not utilizing risk-adjusted pricing, along with the significant differences between maximum values, imply that banks not using risk-adjusted pricing are offering loans at rates similar to the minimum rate offered by banks using risk-adjusted pricing. One might expect banks not using risk-adjusted pricing to add an average risk premium for all borrowers that would result in an interest rate between the minimum and maximum rates offered at banks that use risk-adjusted pricing. Exceptions would occur if most borrowers securing loans at a bank not using risk-adjusted pricing were minimum-risk borrowers.

The lenders were asked to provide the approximate weights given to the following factors when determining a borrower's credit risk: solvency, profitability, debt-servicing capacity, liquidity, repayment history, collateral, and others. As the average weights reported in Table 6 show, collateral and debt-servicing capacity receive the highest weights followed by profitability and then repayment history, solvency, and liquidity. The rankings stayed about the same when the banks were categorized by bank size, except the banks in the $100 million to $300 million category placed a greater weight on debt-servicing capacity and less on collateral. In addition, larger banks (i.e., greater than $50 million) placed additional weight on profitability.

Collateral clearly receives a high weighting in evaluating credit risk for farm real estate lending. Perhaps, however, this result should not be surprising in light of the high quality of collateral generated by farmland. Moreover, the high weight also given to debt-servicing capacity shows a roughly balanced approach between asset security and repayment ability in credit evaluations by these banks.

[12]The same tendency occurred with variable-rate loans.

The credit factors and weights can be used in a variety of approaches to credit evaluation ranging from highly subjective, informal methods to scoring techniques based on sophisticated statistical analyses of the borrower's financial data. However, little is known about the methods agricultural bankers employ in evaluating a farm borrower's credit worthiness. Accordingly, the survey questionnaire asked whether the responding bank uses a credit-scoring worksheet or similar formal system to evaluate a borrower's credit risk on both farm real estate loans and production loans and other loans to farmers. In response, 27% of the banks indicated they employ a credit-scoring or formal approach with farm real estate borrowers.[13] The proportion of banks that use a formal credit-scoring system increases as bank size increases. A higher proportion of banks affiliated with a multibank holding company utilizes a formal credit-scoring system. Since results reported above indicate that 64% of the banks use risk-adjusted pricing, these lower incidences of credit scoring (27%) indicate that rather informal credit-evaluation methods must be employed by a relatively high proportion of the banks.

Comparison with Farm Credit System Policies and Responses

A survey of the St. Louis, Louisville, Omaha, and Minneapolis FCS districts provides additional information about loan terms and pricing that were used by major farm real estate loan competitors during this same time period. Traditionally, the FCS has used primarily variable-rate mortgages. Now, however, each of these districts is also offering fixed- and adjustable-rate mortgages (ARMs) to meet the demands of farm borrowers and to offer a broader range of credit services. Along with the traditional variable-rate mortgage loans, one-, three-, and five-year ARMs, and 5-year fixed-rate loans were offered at each district. Three of the FCS districts also offered longer fixed-rate loans.

[13]Thirty-seven percent of the banks indicated they utilize a credit-scoring or formal approach when evaluating non–real estate farm loans.

The minimum interest rate charged farm borrowers on variable-rate farm real estate loans averaged 10.9%, while the average maximum rate charged on variable-rate loans was 12.1%; these average rate levels were less than the comparable data for agricultural banks. Each district uses a tiered interest-rate structure based on the borrower's credit risk. In one district, the only credit factors considered are the borrower's solvency position (i.e., the equity-to-asset ratio) and the ratio of loan size to appraised value of the land pledged as security. Another uses weights based on capital debt repayment capacity *or* solvency and collateral positions. The other two districts have an evaluation system based on solvency, liquidity, debt-servicing capacity, and collateral, with slightly higher weights given to collateral and solvency.

The minimum loan to appraised value required for farm real estate loans was 25%, with the average of the four districts between 30% and 35% loan to appraised value.[14] The variable rate at the districts changed an average of three to four times during 1988.

The average interest rates offered for one-, three-, and five-year ARMs for the best customers were 11.05%, 11.3%, and 11.41%, respectively.[15] In the case where sixteen- to twenty-year fixed-rate loans were offered, the average rate offered to the best customers was 12.2%. In many cases, the longer-term fixed-rate loans were not offered to the higher-risk borrowers.

Future Goals for Farm Real Estate Lending and Secondary-Market Activity

Considerable uncertainty exists about the future levels of farm real estate lending and the relative position of various types of financial institutions in this market. In agriculture, profit prospects, investment opportunities, and future changes in land values play an important role. In the financial markets, the competitive position of the FCS and life insurance companies is important, as are the activities of savings and loan associations and the efforts of commercial banks to offer full-service financing to farm borrowers. The presence of Farmer Mac introduces additional uncertainties about the extent of use of the new secondary market and its financing implications for all types of lenders.

The bankers responding to this survey indicated a moderately optimistic set of goals for farm real estate lending over the next three years. Table 7 reports survey responses regarding the banks' future goals and anticipated secondary-market activity. Forty-one percent of the banks anticipate that farm real estate loan volume will remain about the same over this period while 51% indicate a goal of increasing farm real estate lending by 10% to 30%, and 1% of the banks indicate a goal of decreasing farm lending by 10% to 30%. Moreover, 25% of the banks anticipate increasing the geographic market for farm real estate lending in the next three years. The proportion of banks indicating a goal of increasing farm real estate loan volume or geographical market area generally increased as bank size increased.

When asked how the new secondary market for farm real estate loans would change their involvement in farm real estate lending over the next three years, 8% of the banks indicated a substantial increase, 30% indicated a slight increase, 53% indicated no change, and 9% were undecided. When considered by bank size, larger banks clearly anticipated greater involvement with the secondary market. Despite the mixed outlook for secondary-market activity, 42% of the banks had purchased Farmer Mac stock at the time of the survey in order to qualify as an originator of loans qualified for sale in the market. About 43% of these banks had been contacted by a potentially certified pooler.[16]

[14]In one case, the 25% criterion could be lowered if the borrower secured an FmHA guarantee, chose a 15-year amortization, 20-year equal-principal payment, or 25-year monthly payment loan. Other exceptions also occurred at other FCS districts.

[15]In general, the interest rates on the ARMs were linked to comparable (in maturity) U.S. Treasury securities, making their attractiveness to borrowers dependent on the current yield curve. At the time of loan origination, two of the districts would base the interest rate charged on a prespecified premium over Treasury securities. The other two districts used similar procedures but allowed some discretionary action by the board of directors to determine a price at the end of the repricing horizon.

[16]These contacts were made prior to March 31, 1989.

Table 7. Future Goals for Farm Real Estate Lending and Secondary-Market Activity

	Goals Regarding Farm Real Estate Loan Volume for the Next 3 Years					Anticipated Impact of Farmer Mac on Bank Involvement in Farm Real Estate Lending				
	Increase More than 30%	Increase 10%–30%	Remain About Same	Decrease 10%–30%	Geographic Expansion Expected	Increase Substantially	Increase Slightly	No Change	Decrease	Purchased Farmer Mac Stock
	Percent of Banks									
All Responses	6	51	41	1	25	8	30	53	0	42
Bank Size, Assets										
Less than $25M (a)	4	45[cde]	48[bcd]	2	20[cd]	9[cde]	22[b]	60[bde]	0[d]	36[b]
$25M to $50M (b)	6[e1]	52[e]	40[a]	1	22	8[cde]	35[a]	51[a]	0[d]	50[ac]
$50M to $100M (c)	7	55[ae]	37[ae]	0[e]	32[a]	3[abde]	30	55[de]	1[d]	37[b]
$100M to $300M (d)	8	60[ae]	32[ae]	0[e]	32[a]	15[abc]	32	41[ac]	2[abc]	41
Greater than $300M (e)	16[a]	21[abcd]	58[cd]	5[cd]	32	22[abc]	33	33[ac]	0	53
Bank Structure										
NO&SBHC	6	49	43	1	23	8	29	53	0	44
MBHC	7	56[2]	36[2]	1	31[2]	8	31	52	1	38

[1]Letters indicate mean significant difference (90% level) between banks of different size classes. Example: "e" in row (b) ($25 million to $50 million) indicates that the mean value in row (b) is significantly different from the mean values in row (e) (greater than $300 million) at the 90% confidence level.

[2]Paired mean values or proportion of banks is significantly different between NO&SBHC and MBHC at the 90% confidence level.

Over 60% of the responding banks in Iowa indicated a purchase of Farmer Mac stock, which was significantly higher than the proportion of banks responding in other states. The banks indicated, on average, that a fixed-rate premium of up to 1.12 percentage points over the rate on a variable-rate loan would allow the secondary loan sales to be competitive to their farm borrowers. Results from Leatham and Baker indicate that farmers would pay up to 1.5 percentage points of interest-rate premium to use some fixed-rate loans.

Concluding Comments

These survey results have provided a timely information base about the present and anticipated future involvement of midwestern agricultural banks in farm real estate lending. In general, the results indicate that the growth in bank loans secured by farm real estate represents a variety of loan purposes, although dominated by purchases of farm real estate, buildings, or land improvements. Substantial refinancing of various types and sources of agricultural loans also occurred in response to the financial stresses of the early 1980s, although the pace of refinancing diminished in 1988. Moreover, the bankers responding to the survey clearly indicated no intentions to decrease their farm real estate lending in the next three years, with more than 50% anticipating growth of more than 10% over this period.

Despite the growth in farm real estate lending by agricultural banks, it remains unclear whether the credit terms involved were well suited to the financing needs of farm borrowers or to what extent the lending programs have been developed as a systematic part of asset-liability management, especially by smaller banks. The heavy reliance by all the responding banks, but especially smaller ones, on fixed-rate loans with relatively short maturities (five years or less) and balloon payments may represent a trade-off between reduction in the banks' interest-rate risk and increases in borrower credit risk. Short maturities with intended roll-overs or renewals provide greater financial controls for the lender. However, these practices also create uncertainties for borrowers about credit availability and interest rates at loan maturity and about meeting potentially higher repayment obligations. To some extent these lending practices of the 1980s represent a return to bank lending of the 1880s when three- to five-year mortgage loans predominated, although a hundred years ago farmers worried as much about the survival of the bank as about the availability of credit.

Asset-liability management remains the primary method that agricultural banks use to cope with interest-rate risk (Ellinger and Barry). Offering both variable-rate along with longer-maturity fixed-rate loans is one asset-liability procedure that banks can use to adjust their desired gap position (rate-sensitive assets less rate-sensitive liabilities) without changing deposit funding sensitivity. In contrast, survey results indicate a relatively low incidence of banks offering both fixed- and variable-rate loans, suggesting a weak linkage between the lending programs and asset-liability management in many banks.

The high incidence of risk-adjusted loan repricing represents considerable progress over time in agricultural bankers' use of price versus nonprice responses to differences among borrowers in their credit risk. However, the lower incidence of credit scoring or formal methods of risk evaluation suggests that substantial opportunity exists for the adoption of more rigorous credit-evaluation procedures. Consistent with findings of other studies (e.g., Barry and Calvert), these survey results indicate that large banks with more-extensive holding company involvement make greater use of more-formal credit-evaluation procedures as well as other lending practices reported in the survey.

The new secondary market for farm real estate loans could have a significant effect on the farm real estate lending practices of agricultural banks. Longer maturities on fixed-rate loans should be possible, and the underwriting standards should stimulate more-widespread and more-uniform practices in credit evaluation, loan documentation, and pricing for banks directly involved in secondary-market transactions and for competing banks as well. Moreover, the bankers' observations about maximum interest-rate differentials

between fixed- and variable-rate loans suggest considerable flexibility for the secondary market to develop and function competitively, although the pricing situation of other types of lenders must be considered as well. Of course, these developments will be based on rather extensive participation in and use of the secondary markets by agricultural banks, and the extent of such participation remains to be seen.

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Determinants of Crop Insurance Protection at Agricultural Banks

Glenn Pederson

Abstract

A model is developed to analyze the role of lender characteristics as determinants of the level of crop insurance protection in bank loan portfolios. Logistic regression of the data from a sample of agricultural banks supports the hypothesis that bankers use crop insurance as a specialized source of liquidity. Crop insurance protection is found to vary according to specialization of the bank in farm loans, profitability of the bank, and presence of a crop insurance agency in the bank.

Key words: crop insurance, banks, logistic regression.

Severity of the 1988 drought and action by the U.S. Congress to limit its adverse financial impacts focused agricultural policy discussions on the performance of the Multiple Peril Crop Insurance (MPCI) program. Low farmer participation in the MPCI program and severity of the drought were two of the factors that prompted federal intervention and passage of the $3.9 billion Drought Relief Act of 1988.[1] Congress also passed the Federal Crop Insurance Commission Act of 1988. Findings of the Commission for the Improvement of the Federal Crop Insurance Program included recommendations for increasing participation and responsiveness to producer needs, program simplification, and improved program administration. More recently, the Bush administration has proposed the elimination of the federally subsidized crop insurance program by 1992—a proposal which may force the Congress to choose between federal crop insurance and disaster-relief programs.

Various reasons have been advanced for low MPCI participation rates, including (1) unwillingness or inability of some farmers to bear the cost of crop insurance, (2) belief by many farmers that crop diversification is an adequate means of risk management, and (3) the perception of farmers that other federal programs, which provide direct cash payments at no additional cost, make crop

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[1]Aggregate participation rates on corn, soybeans, and wheat (as measured by crop acres insured) were reported to be relatively low and quite variable since the program was expanded in 1980 (U.S. General Accounting Office 1988a). A ten-state study of MPCI participation rates during 1987 indicated that 24.9% of eligible crops were covered. State participation rates ranged from 2.9% to 44.9% of planted acres. This compares with a 50% participation-rate target envisioned when the Federal Crop Insurance Act of 1980 was passed.

insurance unnecessary (U.S. General Accounting Office 1988b). Agricultural lenders appear to share some of these popular views about the need for MPCI coverage.[2] However, there appears to be significant variation among lenders in the percentage of farm borrowers who acquire crop insurance coverage. This is particularly evident when one considers the low percentages of crop acres covered annually by MPCI and reported wide variation across agricultural banks in the percentage of farm loan volume insured with MPCI during 1988 (Minnesota Bankers Association).

Responses of Minnesota bankers to a mid-1988 survey indicated that the average percentage of MPCI-insured farm operating loan volume was about 44%. That percentage varied from virtually zero at some banks to 100% at others. Moreover, it is not clear that the observed interbank variation in MPCI participation is explained by the same set of variables that have been used to model farmer demand for crop insurance. The objective of this paper is to identify factors which explain observed variations between banks in the proportion of farm loan volume insured with MPCI.

Previous Studies

Several factors have been found to explain farmer acreage participation rates in previous crop insurance studies (Gardner and Kramer; Nieuwoudt, Johnson, Womack, and Bullock). The expected rate of return to crop insurance was found to be a significant determinant of participation rates, although alternative specifications using indemnities and premiums were considered. Other studies analyzed the economic incentives for farmers to purchase MPCI as a risk-management tool (Kramer and Pope; Lee and Djogo). A recent simulation study by Skees and Nutt evaluated how the cost of crop insurance affected farm financial performance as yield risk and debt levels were varied.

Investigations have also been made into lender responses to farmer use of crop insurance (Pflueger and Barry; Leatham, McCarl, and Richardson). Pflueger and Barry used survey and simulation methods to evaluate how non–real estate lenders responded to farmer use of crop insurance. Approximately 60% of surveyed lenders provided a "positive credit response," although with little change in loan interest rates and maturities. The mean percentage of simulated operating loan requests granted by banks increased significantly with crop insurance. Results generally indicated that crop insurance was a factor in operating and capital credit decisions, but the response was not uniform across banks. Pflueger and Barry did not use data from existing loan portfolios and, therefore, the research did not consider differences in lender response to crop insurance use as a result of variations in bank loan portfolios or bank financial positions.

Leatham et al. used Monte Carlo farm simulation to analyze lender preferences for crop insurance as insurance loss ratios were systematically varied. By incorporating the cost of foreclosure into a present value expression for lender income, they showed that (from a risk-averse lender's perspective) use of crop insurance dominated the "no crop insurance" alternative at all loss ratios. An implication of the study is that greater uniformity of crop insurance use would occur if lenders encouraged farm borrowers to buy crop insurance by adjusting interest rates on loans to account for risk. Yet, bankers have not been observed to use interest-rate premiums (discounts) for that purpose.

It is concluded here that the applied finance literature does not clarify what factors have influenced some banks to carry high levels of crop insurance protection while other banks have carried minimal protection on their farm loans. Previous studies have hypothesized the role of lender preferences in the insurance decision but have not explicitly considered the role of lender economic and financial characteristics as potential determinants of the level of insurance protection.

[2]A survey of agricultural lenders in South Dakota by Pflueger and Schmiesing indicated that lenders perceived two primary reasons why farmers did not purchase crop insurance: the need to reduce cash outlays regardless of risk and the perception that costs of insurance exceeded the expected benefits.

Theoretical Approach

A farmer's incentive to acquire crop insurance has been associated with the potential role it plays as a specialized source of liquidity (Barry, Hopkin, and Baker). Theoretically, the farmer's decision to insure involves consideration of the size of the insurance premium, the likelihood and size of the potential loss (which determines the size of the expected reserve needed), and the differential between the rate earned on invested funds and the rate earned on liquid reserves. With this information, a farmer could calculate the expected gain from insuring. It is useful to recognize that the expected gain theoretically derives from both liquidity and profitability effects. First, a farmer's expected cash available may increase if the unexpected cash requirement due to a crop disaster is averted (the liquidity effect). Second, insurance would allow the borrower to reduce precautionary cash reserves and invest those funds in the business to earn a higher rate of return (the profitability effect).

The approach here is to model a lender's decision to require crop insurance on farm loans analogously to the decision of a farmer to buy insurance. The primary incentive for a lender to require crop insurance derives from an anticipated increase in liquidity and the potential for improved profitability through a reduction in default risk on farm loans. A lender would potentially benefit from improved loan repayment performance (greater asset liquidity) and less reliance on loan collateral if the loan portfolio was adequately insured.[3] The lender's expected gain from insurance is theoretically a function of the cost of insurance, the likelihood and size of potential loss (hence, the size of the reserve needed for loan losses), and the profitability of invested funds.

First, the certainty approach used by Barry, Hopkin, and Baker is modified. They specified the farmer's gain from insurance (g) as

$$g = R(c - e) - P, \tag{1}$$

where R is the size of the needed liquid reserve without insurance; c is the opportunity cost of the reserve if funds are reinvested in the farm business; e is the earnings rate of the liquid reserve; and P is the annual insurance premium.

Barry et al. assume that the probability of an event occurring is the same to a farmer either with insurance or without insurance and with other liquid reserves. Therefore, the farmer's decision is based on whether the value of (1) is positive or negative. If the model were extended to incorporate behavior toward risk, moral hazard would become a consideration (since farmers may adjust their behavior toward preventative measures once they are insured). Additionally, the joint presence of moral hazard and adverse selection among farmers could represent an important basis for explaining low historical MPCI participation rates.

Analogously, the lender's gain from requiring insurance is defined as

$$g(L) = R(L(x,z))[\pi(L(x,z), x) - r] - P(L(x,z)), \tag{2}$$

where $g(L)$ is the distribution of gains from insuring farm loans; R is the loan liquidity reserves requirement function; $L(x,z)$ is the proportion of farm loan volume in the lender's portfolio that is insured; x is the distribution of borrower cash flows; z is a vector of lender financial characteristics; π is the distribution of lender profits from loans; r is the rate earned on liquid reserves; and P is the insurance premium function.

The liquidity reserve needed by a lender to meet contingencies is assumed to be a function of the bank policy on loan insurance, L, which is a function of lender characteristics and the lender's subjective

[3]Binswanger has suggested that crop insurance acts as an imperfect substitute for collateral in the lending decision process. If the insurance is actuarially fair, it acts as a "mean-preserving reduction" in the distribution of borrower returns which increases the expected return on the loan. Binswanger also argued that crop insurance is demanded by banks because it tends to reduce asset-management problems associated with the positive covariance of returns between loans.

distribution of borrower cash flows. A lender that perceives a high variability of cash flows due to insurable events (e.g., crop failure) is expected to require a higher proportion of insured loans. As the proportion of insured loans increases, the lender has less need to hold cash and other liquid assets to meet stochastic demands for cash. Normal loan repayment provides more of the required liquidity. The probability distribution of lender profits on loans (π) represents the opportunity cost of liquidity reserves. The distribution of lender profits is defined so that the probability of loan repayment increases with increases in L. Since loan insurance contracts cover only insurable events, there will always be some probability that cash flows will be insufficient for full repayment. Therefore, lender profits on loans are also randomly determined in part by x.

If the parameters of (2) were known, one could analytically derive the mean-variance properties of the lender's portfolio with and without crop insurance. The lender's expected gain from insuring would be the expectation of (2).

$$E[g(L)] = E[R(L(x,z))]\,E\,[\pi(L(x,z),x) - r] - E[P(L(x,z))]. \quad (3)$$

Equation (3) states that the expected gain from insuring is equal to the expected increase in returns due to insuring, less the expected increase in premiums paid. The variance of the distribution of gains is

$$\sigma^2(g(L)) = R(L(x,z))\sigma^2[\pi(L(x,z),x)]. \quad (4)$$

The variance of gain from insuring is proportional to the variance of profits on loans.[4] Size of the liquidity reserve is a weighting factor in (4).

Since the parameters of the distributions identified in (3) and (4) are not known or easily measured, an alternative expected utility approach is taken to the analysis of lender crop insurance decisions. The lender's expected utility of gain is defined as

$$EU(g(L)) = \int_0^{\infty} U(g(L))\, f(x)dx. \quad (5)$$

The effect of a change in the proportion of insured loans on expected utility can be theoretically found by taking the derivative of (5) with respect to the decision variable, L. The derivative expression is

$$\begin{aligned}\frac{\delta EU(g(L))}{\delta L} &= \int_0^{\infty} U_g(g(L))g_L(L)f(x)dx \\ &= \int_0^{\infty} U_g(g(L))\{R_L \cdot \\ &\quad (\pi(L(x,z),x) - r) \\ &\quad + \pi_L \cdot R(L(x,z)) \\ &\quad - P_L\}f(x)dx, \end{aligned} \quad (6)$$

where subscripts indicate partial derivatives.

The expression in (6) under the integral sign contains two parts. First is the marginal utility of gain, U_g, which is expected to be positive for positive gains. Second, the expression in brackets is the increase in the net return from insuring. The expression in brackets has three components. The first component is the revenues which would be generated as liquidity reserves are reduced (as indicated by R_L) and the funds are invested in assets with higher expected yields (as indicated by $\pi - r$). This is interpreted as the "profitability effect." Although the sign of R_L is assumed to be negative (higher insurance requires less reserves), the effect on expected utility is expected to be positive. This occurs since a downward adjustment in liquidity reserves represents a reduction in the cost of holding reserves and an increase in the gain from insuring.

The second component of the expression in brackets is the increase in lender liquidity associated with an increase in expected repayment performance of insured loans. This is the "liquidity effect," and it may carry a positive or negative sign. If crop insurance premiums are actuarially fair, the incremental effect of higher insurance

[4]One could expand the variance-of-profits term to account for insured and uninsured loans. The resulting expression would include the sum of the variances of profit for insured and uninsured loans and their covariance. An argument could be made (similar to that of Binswanger) that this covariance term, although positive, is smaller than the covariance of returns on loans when crop insurance is not used.

protection on bank profits would theoretically be zero, and the liquidity effect would vanish. However, if crop insurance premiums are not actuarially fair, the liquidity effect would be positive when the expected marginal return from insuring is positive (negative when the expected marginal return from insuring is negative).

The final component in brackets is the increase in premiums paid to insure loans. It is assumed that the lender would advance funds to the borrower to purchase the crop insurance. It follows from the above discussion that the sign of (6) is positive if the expected return to insuring is positive. The sign of (6) is indeterminate if the expected return to insuring is negative. In this case, the sign would depend on the magnitudes of the profitability and liquidity effects.

Empirical Models

Two alternative models are specified in this section. Model I assumes that crop insurance protection at agricultural banks is simply an aggregation of farmers' individual insurance decisions. This model can be used to test the implication that interbank variation in crop insurance coverage is independent of the bank variables implied by (6). Model II is based on equation (6) and assumes that bank profitability, liquidity, and loan-portfolio characteristics influence the decision on level of insurance protection.

Model I

Specification of the expected return from insurance in a lender model raises some unique questions as well as some which have appeared in earlier farmer crop insurance demand studies. Various measures, such as the loss (indemnity/premium) ratio, have been used to measure the expected return to insurance (Leatham et al.; Skees and Nutt). However, Gardner and Kramer note that insurance premiums may have been adjusted over time to equalize expected indemnities and premiums. Consequently, historical premium levels may distort the return-to-insurance computation. Additionally, it is likely that the contract terms for indemnities were changed over time due to changes in loss experience. Although a loss ratio could be used for analyzing individual farm insurance decisions, it is expected to be less relevant to the insurance-protection decision of farm lenders where the focus is on a portfolio of such farm loans.

Gardner and Kramer specified an expected rate of return for the purpose of analyzing aggregate (county-level) MPCI participation of farmers. The rate of return measure was defined as the ratio of historical average indemnity to average liability (numerator) divided by the ratio of current premiums paid to current liability (denominator) minus one. The numerator of this expression captures expectations of the proportional payout of the insurance contract. The denominator is similar to expressing the current price of a lottery ticket as a percentage of the maximum current reward. The resulting measure (*MPCR*) differs from the loss-ratio concept since both the expected indemnity and the premium are scaled by the level of liability coverage. This scaling would appear to be important when analyzing aggregate responses or, in this case, bank-level protection.

Crop-hail insurance could be considered as an imperfect substitute for MPCI. The alternative of crop-hail insurance has not been incorporated in previous studies, yet it is a potential substitute for MPCI in a lender's portfolio in areas where hail is an important weather hazard. If lenders compare the expected rate of return to crop-hail insurance with the expected rate of return to MPCI, they are expected to recommend the highest-return option. As a result, the level of MPCI protection and the expected return on crop-hail insurance (*CHRR*) are expected to be inversely related.

If variations in the expected rate of return to MPCI do not adequately capture systematic differences in regional risks, there will be an errors-in-variable problem when estimating Model I (Gardner and Kramer). To account for these geographic differences, the coefficient of variation for yields of the three major crops grown in the lender's service region (*CVMC*) is specified as an indicator of relative yield risk. Crop

insurance protection is expected to be higher among farmers (and, therefore, among lenders) in regions with higher yield variability.

Model II

Equation (6) suggests an alternative model approach to predicting lender crop insurance coverage. Since the gains from insuring are theoretically a function of the profitability and liquidity of the lender, and related characteristics of the lender's loan portfolio, these are specified as determinants of insurance protection. Overall profitability is measured by the lender's rate of return on average assets (*ROAA*). This measure is expected to be positively related to the level of insurance protection since it indicates the expected rate of return earned on assets and is assumed to exceed the rate earned on liquid reserves.

The precautionary liquid reserve on loans is measured by the lender's overall liquidity position. The average loan-to-deposit ratio (*ALTD*) is a frequently used measure of bank liquidity. As the loan-to-deposit ratio increases, bank liquidity (from internal sources) falls. It is hypothesized that an inverse relationship exists between lender liquidity and the level of crop insurance protection. Thus, the loan-to-deposit ratio and the level of insurance protection are expected to be positively related.

Loan portfolio characteristics play a role in the lender's decision to require crop insurance due to the potential for several relationships between profitability of the loan portfolio and the likelihood and size of expected loan losses. Specialization in farm lending is expected to induce the lender to control overall credit risk exposure by requiring crop insurance on a greater proportion of farm operating loans. Two measures of loan portfolio specialization are identified: the total agricultural-loan-to-total-loan-volume ratio (*AGLR*) and the proportion of crop loan volume in the total farm operating loan portfolio (*PCRL*). Both variables are expected to be positively related to the level of crop insurance protection. Since farm operating loans are usually secured either by a lien on the crop being produced or by other inventories, a lender may consider the availability of crop and feed inventories as an indicator of a borrower's ability to repay a loan in the event of a disaster. If crop and feed inventories are pledged as collateral, they are assumed to serve as substitutes for insurance. The proportion of loans where sufficient crop and feed inventories exist to repay the loan balance (*COLL*) is expected to be inversely related to the level of insurance protection.

Evidence has been found that the proportion of insured farm loans at commercial banks varies by loan quality and whether the bank sold crop insurance through an agency of the bank (Pflueger and Schmiesing). The expectation is that if a bank sells insurance, the proportion of farm operating loans carrying crop insurance will be higher.

Data

Data were obtained from four primary sources: (1) a mail survey of agricultural banks in Minnesota conducted during July 1988 (Minnesota Bankers Association); (2) annual Uniform Bank Performance Reports (UBPRs) for 1985–87 (Ninth District Federal Reserve Bank); (3) published actuarial data (Crop-Hail Insurance Actuarial Association and Federal Crop Insurance Corporation); and (4) published crop production data for 1980–87 (Minnesota Agricultural Statistics Service). The mail survey was sent to 371 agricultural banks located in Minnesota to request information about farm loan portfolios and the severity of drought conditions. Surveys were returned by 154 bankers, and 84 surveys were sufficiently complete to be included in this analysis. Table 1 contains summary statistics from the surveys and UBPRs of responding banks.

Responding banks were typically small. Mean total earning assets were $21.25 million at the end of 1987. Mean total farm loan volume was $5.23 million and average farm operating loan volume totaled $2.45 million in mid-1988. Agricultural loans represented about 36% of total loan volume on average at the end of 1987 and ranged widely from 8% to 70%. Operating loans to crop farms averaged about 42% of total farm operating loan volume during 1988 and varied from 0% to 100%. Bank capital

Table 1. Financial Characteristics of Responding Agricultural Banks

Item	Unit	Mean	Standard Deviation	Minimum	Maximum
Total Earning Assets (12/87)	(000)	$21,250	$11,940	$6,872	$54,560
Total Farm Loan Volume (6/88)	(000)	$5,228	$3,643	$980	$17,480
Farm Operating Loan Volume (6/88)	(000)	$2,446	$3,019	$260	$11,100
Farm Loans/Total Loans (6/88)	(%)	35.6	15.6	8.1	70.1
Capital/Total Assets (12/87)	(%)	9.37	2.74	1.50	18.16
Return on Average Assets	(%)	0.16	0.95	−2.97	1.78
Average Total Loans/Average Total Deposits	(%)	52.1	11.7	13.2	76.2
Farm Operating Loans Insured with MPCI (6/88)	(%)	43.9	33.4	0	100.0
Return on MPCI	(%)	−11.49	42.52	−78.23	139.90
Return on Crop-Hail Insurance	(%)	−23.67	52.17	−91.17	229.60
Coefficient of Variation on Major Crop Yields		.143	.045	.094	.263

averaged 9.37% of total assets at the end of 1987, but ranged from 1.50% to 18.16%. The mean rate of return on average assets was 0.16% during 1985–87, and varied from −2.97% to 1.78%. Average total loans were estimated to be 52% of average total deposits across the responding banks in 1987, but varied from 13% to 76%. Responding bankers indicated that the average percent of total farm operating loan volume insured with MPCI was 43.9%. Ten bankers reported zero MPCI coverage and twelve bankers indicated that all their farm operating loan volume was covered with MPCI.

The rates of return on MPCI and crop-hail insurance were derived from county-level data from 1981–87 according to the method suggested by Gardner and Kramer. The mean rates of return on both forms of crop insurance were estimated to be negative and return estimates had large standard deviations (Table 1). The negative mean rate of return estimates indicate that, on average, these crop insurance alternatives had higher expected costs (premiums) than expected benefits (indemnities) per dollar of liability coverage in counties where responding bankers were located. The wide range on estimated rates of return (from −78.23% to 139.90% for MPCI) indicates that insured farmers in some counties might have expected significant positive net benefits from MPCI, while the expected net costs of insuring were also quite high in other areas of the state. The coefficient of variation of yields among the three major crops grown in each county (according to planted acreage) was computed to estimate systematic yield risk differences across counties. The estimated coefficient of variation did not vary widely at the county level (.094 to .263) and may understate the actual variability of crop production experienced by a given bank.

Model Estimation and Results

The dependent variable in both of the preceding models is the percentage of farm operating loan volume insured during 1988. Since that percentage is restricted at 0 and 1, the appropriate estimation technique is that for an ordinal limited dependent variable.[5] Rosett and Nelson show that a two-limit model can be specified where the dependent variable, Y, is defined by

$$\begin{aligned} Y_t &= L_{1t}, && \text{when } Y_t^* - e_t \le L_{1t}; \\ Y_t &= L_{2t}, && \text{when } Y_t^* - e_t \ge L_{2t}; \text{ and} \\ Y_t &= Y_t^* - e_t, && \text{when } L_{1t} \le Y_t^* - e_t \le L_{2t}, \end{aligned}$$

where Y_t^* is a linear function of the independent variables in the model, and e_t is the normally distributed, random error term with mean zero and standard deviation, σ. The resulting equation can be estimated using maximum-likelihood methods. In this analysis, Y_t^* is the percentage of MPCI-insured loans. Ordered

[5]Previous applications of the ordinally ranked, limited dependent variable have been made to the problem of credit-scoring farm loans (e.g., Lufburrow, Barry, and Dixon).

logit is used to estimate the parameters of the models. Results are reported in Table 2.

Regression coefficients in Model I for the rate of return variables (*MPCR* and *CHRR*) are highly significant but carry unexpected signs. The sign on *MPCR* should be positive if an increase in the expected rate of return to insuring induces the bank to carry a higher level of MPCI protection. Similarly, if the expected return to crop-hail insurance is positive, a bank would require less MPCI and more hail insurance to obtain adequate substitute coverage. Thus, a negative sign is expected on *CHRR*. The estimated coefficient on the coefficient of variation on yields (*CVMC*) carries the expected positive sign and is highly significant. Among banks located in areas with systematically higher yield risk, there is a higher probability that loans will be covered by MPCI insurance. The dummy variable for a bank insurance agency selling MPCI (*AGEN*) was not significant. The chi-squared statistic indicates that Model I is significant at the 2% level.

Results from Model II indicate that bank variables do explain a significant amount of the level of bank insurance protection. The estimated coefficient on the percentage of agricultural loans (*AGLR*) has the expected positive sign and is highly significant. Banks with greater specialization in agricultural loans (less loan portfolio diversification) have a higher probability of carrying MPCI insurance protection. The coefficient on the bank profitability variable (*ROAA*) is positive as hypothesized, but is only significant at the 15% level. This provides some evidence that banks with an opportunity to earn a higher rate of return will carry higher levels of MPCI protection to reduce the need for liquid reserves. The bank liquidity variable (*ALTD*) has an unexpected positive sign, but is not significant. The bank insurance agency dummy variable (*AGEN*) has the expected positive sign and is significant at the 14% level. Model II is significant at the 5% level.

Table 2. Results of Ordered-Logit Regressions

Variable	Model I	Model II
MPCR	−.0088****[a]	
	(.0040)	
CHRR	.0084****	
	(.0027)	
CVMC	9.9424****	
	(1.9830)	
AGLR		.0258****
		(.0084)
ROAA		.2329*
		(.1634)
ALTD		.2443
		(.6301)
AGEN	.0412	.4191*
	(.3016)	(.2813)
Log-Likelihood	−55.77	−57.03
Chi-Squared	15.38	12.86
Pseudo-R^2	.12	.10

[a]Significance levels are: ****(1% level); ***(5% level); **(10% level); and * (15% level).

The pseudo-R^2 statistics indicate that Model I explains slightly more of the total variance of crop insurance protection than does Model II. However, problems with incorrect signs on the rate of return variables in Model I lead to the conclusion that Model II is a better representation of banker insurance decisions. Model II was used to predict membership of banks in the three insurance groups. All sixty-two banks with insurance coverage between 0% and 100% were correctly classified by the model. However, none of the ten banks which reported zero MPCI coverage were properly classified. All of these banks were placed in the group with coverage levels above zero. Similarly, only one of the twelve banks reporting 100% coverage was correctly placed. The overall predictive accuracy of Model II is 75%. A review of the actual-versus-predicted grouping of banks was done to identify why Model II was unable to properly classify a higher percentage of the banks which reported either zero or 100% MPCI coverage. The probabilities for three borderline cases in the extreme groups were sufficiently close between the actual and predicted probabilities that the overall classification rate could be increased to 79% (when these cases were considered correctly classified). With these adjustments, the model predicts slightly better (25%) among banks reporting 100% MPCI coverage than it does among banks reporting zero coverage (10%).

These empirical results, while interesting, also point out some areas in which to improve the estimation of Model II as an application of the proposed theoretical

model. First, the data set is relatively small; a larger set of responding banks would have added support for the results which were obtained. Second, bank responses concerning the level of MPCI-insured farm operating loans needed to be interpreted in some of the returned surveys. These cases occurred primarily among banks reporting zero or 100% coverage. Thus, reporting errors may have affected predictive ability in those extreme groups. Third, it may be useful to develop measures of bank profitability and liquidity which more specifically capture the banker's expected level of profitability and the size of liquid reserves associated directly with undercollateralized or high-risk farm loans. These represent potential areas for additional research in the role of insurance in bank liquidity management.

Summary and Conclusions

Previous studies have considered the role of agricultural lenders in the farmer's decision to purchase Multiple Peril Crop Insurance. However, these studies have not attempted to explain why there is a wide variation between banks in the percentage of farm loan volume covered by crop insurance. Two alternative approaches to the question of crop insurance protection were explored in this paper. The first approach assumes that bankers are passive participants in the crop insurance decisions of their farm clients. More specifically, crop insurance protection is simply an aggregation of individual farmer decisions. The implication is that determinants of farmer decisions on crop insurance (expected rate of return and risk) also explain the observed variation between banks. The second approach assumes that lenders view crop insurance as a specialized source of liquidity. It is shown that the gain from requiring crop insurance is a function of characteristics of the lender's asset portfolio, profitability, and liquidity position.

The first approach is rejected based on the empirical model results. The expected rate of return variables carry signs that are inconsistent with expected behavior and prior analyses of farmer crop insurance participation rates. The relationship between bank insurance protection and systematic variations in yield risk is significant and consistent with expected behavior. However, this latter result alone is ambiguous since it is unclear whether the insurance response to production risk is due to recognition by the borrower or by the lender.

The analysis of bank-level data generally supports the bank liquidity-management hypothesis. Crop insurance protection among a sample of agricultural banks was found to vary according to specialization of the bank in agricultural loans, the underlying profitability of the bank, and presence of an insurance agency in the bank. An unexpected result was that the estimated model does not support the overall bank liquidity position variable as a factor in the MPCI protection decision.

Banks with higher concentrations in farm loans appear to be using MPCI to reduce the variance of returns on loans and the dependence on loan collateral. Crop insurance may be providing a more cost-effective way for those banks to reduce the likelihood of asset-management problems if a disaster should occur. Banks experiencing higher levels of profitability appear to carry higher levels of MPCI protection due to the opportunity to reinvest excess liquid reserves at a higher rate of return. One interpretation is that those bankers use crop insurance as part of their strategy for improving the allocation of bank assets. The relationship between the insurance agency and level of crop insurance protection appears to be related to geographic risks and local market demand for crop insurance services. Areas in which crop risks are systematically greater may provide a viable insurance market and one which is profitable for the bank to pursue.

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A Present Value Analysis of Land Transactions and the Proportion of Seller Financing

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Abstract

This paper deduces maximum bid and minimum sell price models with and without seller financing to assist in explaining recently observed trends in land sales. With the decline in land values and the passage of the Tax Reform Act of 1986, land transactions have increased while the percentage of land sales financed by sellers has decreased. This paper uses a present value framework to explain both trends.

Land is considered by most to be an illiquid asset. Only a small percentage of U.S. farmland is traded each year. Nevertheless, land's immobility and durability make it desirable collateral for loans. Since those who pledge it as security for loans can't move it or alter it significantly without detection, a lender's interest in the land is protected. Consequently, land and buildings on the land provide security for many loans, especially in the agricultural sector of the economy where land represents a large portion of the capital assets. In addition, its desirable characteristics as loan collateral allow many who are not specialized financial institutions, such as the sellers of the land, to lend based on land collateral.

Information on the volume of land transfers is very sparse, but available evidence suggests the rate of transfers has increased in recent years. For example, in a July 1987 report, the USDA authors indicate "The number of reported sales increased by about 5 percent for the year ending February 1, 1987." In June 1988, the USDA reported that "According to the 1988 survey results, sales activity was higher than a year earlier."

Another observed trend in the land's transaction data is the changing share of farm mortgage loans provided by sellers. The relative share of seller-financed loans seems to have peaked in 1981 or 1982 and has generally declined since then. Furthermore, following the passage of the Tax Reform Act (TRA) of 1986, the relative share of farm mortgage loans provided by individuals and others has decreased significantly. Table 1 shows the percentage of credit volume extended by sellers for farmland transfers from 1980 to 1988 for the Corn Belt, Lake States, Northern Plains, and Southern Plains regions.

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One purpose of this study is to explore how changes embodied in the TRA of 1986 influence the purchase and sale of land. In addition, we examine the effect of how the repeal of the exclusion for long-term capital gains contained in the TRA of 1986 altered the incentives for seller financing.

There are a variety of factors which likely explain the increase in the volume of land transfers and the decrease in the proportion of seller financing. Financial stress of the early to mid-1980s may have forced farms with low incomes to voluntarily liquidate assets. Likewise, the droughts of 1988 and 1989 may have forced additional land on the market. Sellers who sold land under land-contract arrangements often suffered significant financial losses when buyers were forced into delinquencies or bankruptcies. These problems have created a greater awareness of the risks associated with land-contract sales.

Our purpose in this article is not to develop a full explanatory model of farmland sales volume and the proportion of seller financing. Data limitations prevent such a complete analysis. Rather, our efforts will focus on the effects of the TRA of 1986 on the incentives for selling land and on the incentives for sellers to provide financing.

In what follows, simplified maximum-bid and minimum-sell models are developed for buyers and sellers of land, respectively. These are extensions of those discussed by Robison, Koenig, and Kelsey. The deductive results show how such factors as taxes, inflation, real-income growth rates, and interest rates on seller-provided loans influence maximum bid and minimum sell prices. In the last section, we summarize our results and conclusions, and describe where further work is needed to explain transactions levels in the U.S. agricultural land market.

Maximum Bid, Minimum Sell, and Value in Use

The value of long-term assets such as land can be determined in present value models by estimating future cash flows discounted by the opportunity cost of the firm. Cash flows generated by land include: (1) cash flows from the use of land as a productive investment; (2) cash flows associated with taxes, including income taxes, property taxes, and capital gains taxes; (3) cash flows from the sale or purchase of the land; and (4) cash flows associated with the financing of the asset.

The differences between the maximum bid price model and the minimum sell price model for land can be described in terms of challengers, or potential investments under consideration, and defenders, or existing investments of the firm. In the maximum bid price model, the land, described by its cash inflow stream, is the challenger. The discount rate describes the average rate of return associated with the best alternative asset, the defender. In the minimum sell price model, the reverse is true. The defender is the land to be sold, described by cash flow streams given up by the seller. The challenger is the discount rate since it represents the rate of return the seller expects to earn on the proceeds received from the sale of land.

Another difference between the maximum bid and minimum sell price models is the sale price of land agreed on by a buyer and seller. For the seller, the sale price is a return; for the buyer, it is a cost. Therefore, any decrease in the price of land is welcomed by the buyer. Meanwhile, any

Table 1. Percentage of Credit Volume Extended by Sellers for Farmland Transfers from 1980 to 1988, by Region and Year

Region	Year								
	1980	1981	1982	1983	1984	1985	1986	1987	1988
	Percent								
Corn Belt	34	38	37	37	32	27	30	20	17
Lake States	55	59	60	44	44	49	53	41	39
Northern Plains	41	44	35	32	27	25	49	24	19
Southern Plains	30	43	43	31	23	24	30	15	14

Source: "Agricultural Resources: Agricultural Land Values and Markets," *Situation and Outlook Report*, USDA, ERS, AR-10, June 1988.

reduction in the price of land is a penalty for the seller.

The model is further complicated by introducing taxes. There are three different kinds of taxes to consider: the income tax associated with the cash-flow stream; the capital gains tax, which is some proportion of the income tax; and the property tax, which is some proportion of the market value of the asset. Historically, the capital gains tax rate has been 40% of the income tax rate. However, the Tax Reform Act of 1986 made 100% of the realized gain subject to the income tax rate. Property tax is the payment which the holder of the land makes each period to the government for the privilege of ownership. It also might be considered as a payment for benefits that accrue disproportionately to owners of land—such as road maintenance, power lines, etc. One complication property taxes create is that they are charged against the market price of land in each period. Thus, each period the model must estimate the maximum bid price for land.

We proceed by analyzing the equilibrium value of land for two models: the maximum bid price model and the minimum sell price model. In both models, net present value (NPV) is set equal to zero. Thus, the discount rate in both models must equal the internal rate of return (IRR). By assuming that after-tax rates of return must be equal on all assets—after adjusting for risk and liquidity—this allows us to solve for the equilibrium value of land.

Before beginning the analysis, it is important to recognize an important simplification retained in the model. The buyer of land in the maximum bid price model never considers selling. Thus, the buyer avoids paying the capital gains tax in the future. This simplifying assumption is justified in cases where the buyer passes land on to heirs who receive a "stepped-up" basis, thus avoiding payment of such taxes. The seller in the minimum sell price model considers selling only once and that is in the current period.

The Maximum Bid Price Model

Assuming the before-tax cash-flow stream grows at a constant rate each period, the cash-flow stream associated with the maximum bid price model can be written as:

$$V_o^b(1+c) = \frac{R(1+g)(1-T) - V_o^b T_p(1-T)}{(1+r_f)} + \frac{R(1+g)^2(1-T) - V_o^b(1+g)T_p(1-T)}{(1+r_f)^2} + \ldots, \tag{1}$$

where V_o^b is the maximum bid price in the current period; c is buyer's transactions costs as a percentage of land's purchase price; R is the before-tax cash flow in the initial period; g is the percentage growth rate per period of before-tax cash flows; T is the marginal income tax rate; T_p is the property tax rate; and r_f is the equilibrium after-tax rate of return.

Recognizing the geometric factor in (1) and solving for V_o^b, we find the maximum bid price of land equal to:

$$V_o^b = \frac{R(1+g)(1-T)}{(r_f - g)(1+c) + T_p(1-T)}. \tag{2}$$

From (2) we see that as the before-tax cash flow or expected growth rate of cash flows increases, the amount the buyer is willing to pay for land increases. On the other hand, as transactions costs, taxes, or the opportunity cost of funds increase, the amount that the buyer is willing to pay for land decreases.

The Minimum Sell Price Model

The minimum sell price model is constructed in a way similar to the maximum bid price model. However, several important differences should be noted. First, the seller is assumed to have originally bought his or her land t periods earlier at a price of $V_{(-t)}^b$. If $V_{(-t)}^b$ is less than the

current selling price of V_s, the seller pays capital gains taxes. If $V^b_{(-t)}$ is more than the current selling price of V_s, the seller reduces his or her tax obligation. Another difference is, of course, the transactions fees that the seller pays. In addition to reducing the income to the seller from the selling price of the land, these fees will also reduce capital gains taxes, which are only paid on the net return from the sale of land. Like the maximum bid price model, however, the property tax rate is assessed against the inflating maximum bid price since the market price can never exceed the most a buyer is willing to pay. We can write the cash-flow stream associated with the minimum sell price model as:

$$V^s_o(1 - s) - [V^s_o(1 - s) - V^b_{(-t)}(1 + c)]\alpha T = \frac{R(1 + g)(1 - T) - V^b_o T_p(1 - T)}{(1 + r_f)} + \frac{R(1 + g)(1 - T) - V^b_o(1 + g)T_p(1 - T)}{(1 + r_f)^2} + \ldots, \quad (3)$$

where V^s_o is the minimum selling price of the land in the current period; s is the seller's transactions costs as a percentage of land's sale price; α is the capital gains tax rate adjustment; and $V^b_{(-t)}$ is the previous purchase price of land paid t periods ago.

Recognizing the two geometric series on the right-hand side of (3) and substituting for V^b_o, we solve for V^s_o to obtain the minimum sell price equal to:

$$V^s_o = \frac{[V^b_o - \alpha T V^b_{(-t)}](1 + c)}{(1 - s)(1 - \alpha T)}. \quad (4)$$

Recall that V^s_o is the smallest price acceptable to the seller. Thus, a change in a variable on the right-hand side of (4) that increases V^s_o implies the seller requires increased compensation to sell. From (4) it is clear that an increase in the current before-tax cash flows, the expected growth rate of future cash flows, or transactions costs to the seller will cause the minimum selling price to increase. On the other hand, an increase in the original purchase price of the land, the opportunity cost of funds, or the transactions costs when the seller purchased the land will cause the minimum selling price of the land to decrease. Increases in the marginal income tax rate or the proportional capital gains tax may cause the minimum selling price of land to increase or decrease depending on the amount of capital gains or losses.

Land Values and Asset Liquidity

Before proceeding, it is necessary to clarify the necessary condition required for a land sale to occur. We will assume that a sale occurs (does not occur) when a given asset is liquid (illiquid). Liquid and illiquid assets are defined as follows.

DEFINITION 1. An asset is liquid (illiquid) if its value in use is bounded from above (below) by the maximum bid price (V^b_o) and below (above) by the minimum sell price (V^s_o).

Thus, for land to be traded $V^b_o \geq V^s_o$. If $V^b_o < V^s_o$, then the land is termed illiquid and will not be traded. Given this definition, equations (2) and (4) can be used to analyze the conditions under which sales transactions will occur and the impacts of changes in various parameters on the likelihood of a transaction occurring.

The implications of the model under the assumptions of perfect markets can now be stated:

RESULT 1. If there are no transactions costs or capital gains taxes and both the buyer and seller are in the same tax bracket and hold identical expectations about future earnings, then land is liquid and a transaction *may* occur.

This result is easily seen by setting transactions costs and capital gains equal to zero (i.e., $s = c = \alpha = 0$) in equations (2)

and (4) and allowing the marginal tax rates and the expected growth rate of future earnings for the buyer and seller to be identical. This yields the result $V_o^s = V_o^b$ and thus the buyer and seller may be willing to engage in transactions, although there would be no advantage gained by either for doing so.

Relaxing the assumption of no transactions costs and zero capital gains tax yields the second result of the model:

RESULT 2. If investors are in identical marginal tax brackets and hold identical expectations, the land will be illiquid if transactions costs exist or capital gains taxes are incurred.

This result is seen by respectively allowing $s > 0$, $c > 0$, or $\alpha > 0$ with $V_o^b > V_{(-t)}^b$ in equations (2) and (4). Each case results in $V_o^s > V_o^b$, thus precluding the possibility of a land transaction.

Land sales, of course, can and do occur even in the presence of capital gains tax and transactions costs. The model provides several possible explanations for this behavior.

RESULT 3. Land *may* be liquid in the presence of capital gains taxes and transactions costs if the buyer's expected growth rate in earnings is greater than the seller's or if the seller's marginal tax rate is greater than the buyer's.

This result is seen by starting from the case where transactions costs and capital gains taxes are set to zero ($s = c = \alpha = 0$) in equations (2) and (4) and then letting the expected growth rate of the buyer (g^b) be greater than the expected growth rate of the seller (g^s), or by letting the marginal tax rate of the seller (T^s) be greater than that of the buyer (T^b). In each case, this results in $V_o^b > V_o^s$, implying that a transaction will occur. The argument can then be made that even if $s > 0$, $c > 0$, or $\alpha > 0$, and $V_o^b > V_{(-t)}^b$, it is still possible that $V_o^b > V_o^s$ if $g^b > g^s$ or $T^s > T^b$. Clearly as g^b increases relative to g^s and/or as T^s increases relative to T^b, the likelihood of a land transaction occurring increases even in the presence of transactions costs and capital gains taxes.

There is one other important event that can cause the likelihood of a transaction occurring to increase. This event is related to the level of capital gains or losses that the seller will incur upon the sale of the land and is summarized as follows:

RESULT 4. As the level of capital gains (losses) increases, land becomes less liquid (more liquid).

Result 4 is demonstrated by differentiating the quantity $V_o^s - V_o^b$ with respect to $V_{(-t)}^b$. Using (2) and (4), the result is:

$$\frac{d(V_o^s - V_o^b)}{dV_{(-t)}^b} = \frac{-\alpha T(1 + c)}{(1 - \alpha T)(1 - s)} < 0. \qquad (5)$$

An explanation for this result follows. Reducing capital gains reduces capital gains taxes and actually produces a tax deduction when capital losses have been realized; but only if the land is traded. So when large capital losses were experienced in the Midwest and Lake States, land transactions may have increased to capture the tax savings created by the capital losses. The sellers of land would, of course, achieve tax savings only if taxable incomes were positive without the capital losses. Using a similar argument, one might expect land transactions to decrease as the amount of capital gains increases. For example, from 1973 to 1978 the Index of Land Values for the U.S. rose from 150 to 308. During the same time period, the total number of farmland transfers declined from 107,000 to 67,300.

There was another event that, coupled with capital losses (gains), added incentives (disincentives) to sellers and buyers to complete land transactions. The Tax Reform Act of 1986 increased the capital gains tax rate from 40% of the income tax rate to 100% of the income tax rate.[1] The implication was that capital losses (gains) after the TRA of 1986 would generate still greater tax savings (liabilities) and further increase (decrease) the incentive to sell land. This result can be summarized as:

RESULT 5. Increases in the capital gains tax rate will tend to increase the liquidity of land if capital losses exist and those losses can be used to offset other taxable income. If capital gains exist, then an increase in the

[1]It should be noted that the TRA also changed the value of the income tax rate for many buyers and sellers although the change was phased in gradually over a number of years starting in 1986.

capital gains tax rate will tend to decrease the liquidity of land.

To demonstrate this result deductively, we differentiate $(V_o^s - V_o^b)$ with respect to α yielding

$$\frac{d[V_o^s - V_o^b]}{d\alpha} = [V_o^b - V_{(-t)}^b]\left[\frac{T(1+c)}{(1-s)(1-\alpha T)^2}\right] \gtreqless 0, \text{ if } V_o^b \gtreqless V_{(-t)}^b. \tag{6}$$

Since capital losses were common in the 1980s, a general increase in land sales after the TRA was expected. For example, in Minnesota, land sales increased from 113,714 acres in 1985 to 150,696 acres in 1986 and 206,995 acres in 1987 (Schwab and Raup). Consequently, whether or not the TRA of 1986 increased or reduced the liquidity of land depended on the difference between the current bid price and the original purchase price. If $(V_o^b - V_{(-t)}^b) > 0$, the TRA increased transactions costs associated with the sale and made land less liquid. Meanwhile, if $(V_o^b - V_{(-t)}^b) < 0$, the TRA increased the tax savings and generated an additional return to land that could only be claimed if the land were sold and the seller had other taxable income. These two features, the TRA of 1986 and capital losses, made land more liquid.

Seller Financing

Under the current tax laws, a land buyer may not deduct the price paid for real estate from his or her taxes. Improvements on the real estate, such as fences, buildings, and drainage tile, are tax deductible. Likewise, interest paid on the loan is fully tax deductible. From the buyer's perspective, taxes paid can be reduced if the land could be purchased at a low price in exchange for an above-market interest rate. On the other hand, before the capital gains rate was increased to the income tax rate, the seller would have preferred to lower interest income by offering a below-market interest rate while offering an increased land sale price. Which of these arrangements would actually have been selected before the TRA depended on the amount of capital gains or losses and the relative income tax rate of the buyer and seller.

Seller financing also allows the seller to delay the payment of any capital gains that occur as a result of the sale because capital gains taxes are only paid in proportion to the amount of principal payments received each period. Thus, the present value cost of the capital gains tax can be reduced by using seller financing. On the other hand, seller financing also delays the receipt of any tax savings that result from capital losses on the sale of the land because the tax savings are also received in proportion to the amount of principal received each period. Thus, seller financing becomes relatively more (less) desirable if capital gains (losses) are incurred by the sale of the land. To see how seller financing affects our maximum (minimum) bid (sell) model, consider the after-tax present value of a loan at interest rate r^* that may be different than the market rate of interest, r_f.

Buyer's Perspective

For deductive purposes, it will be convenient to suppose the borrower is required to repay only interest expenses plus a downpayment. While this is an abstraction, if the growth in land values (g) is positive, the abstraction approaches reality. If $g > 0$, the ratio of amount loaned to the current value of land decreases over time because V_t^b increases at a rate of g percent. Thus, the real balance of the asset financed decreases even though no principal payments are made.

Assume that the buyer pays D percent of the purchase price as a downpayment and finances the remaining amount through the seller. If $(1-D)V_o^{bf}$ is financed at r^* percent, the present value of the interest payments, $PV[(1-D)V_o^{bf}]$, equals:

$$PV[(1-D)V_o^{bf}] = \frac{r^*(1-T)\,V_o^{bf}(1-D)}{(1+r_f)} + \frac{r^*(1-T)\,V_o^{bf}(1-D)}{(1+r_f)^2} + \ldots = \frac{r^*(1-T)\,V_o^{bf}(1-D)}{r_f}. \quad (7)$$

Clearly, neither the buyer nor the seller will agree to a seller-financed land purchase unless they are at least as well off as without it. If $r^*(1-T) < r_f$, then the present value of the loan will be less than the loan value. To offset this, the land's sale price with financing, V_o^{bf}, must be greater than without financing, V_o^b. The buyer, on the other hand, will agree because on an after-tax present value basis he or she pays less than the sale price, V_o^{bf}.

We can find the maximum amount the buyer will pay by setting the value of the seller-financed sale equal to the discounted value of the land's cash flows.

$$V_o^{bf}(D+c) + (1-D)V_o^{bf}r^*(1-T)/r_f = V_o^b(1+c). \quad (8)$$

Then, solving for V_o^{bf} after substituting for V_o^b, we find:

$$V_o^{bf} = \frac{V_o^b r_f(1+c)}{Dr_f + (1-D)r^*(1-T) + cr_f}. \quad (9)$$

Clearly, if $D = 1$, or $r^*(1-T) = r_f$, V_o^{bf} in (8) reduces to V_o^b in (2). It should also be clear that V_o^{bf} and r^* in (9) are clearly inversely related.

Seller's Perspective

The seller's goals may be consistent with those of the buyer if between them they can adjust financing and the exchange price to minimize the present value of tax payments. If this is possible, they can both be made better off. This opportunity to reduce taxes has likely been a factor in determining the amount of seller financing of real estate. It must be kept in mind, however, that the tax-reducing incentives for the buyer and seller do not always occur in the same direction. Moreover, recent changes in the tax laws have altered the methods that must be followed to achieve the desired tax reduction.

Specifically, consider the case for a seller when the capital gains tax rate was less than the income tax rate. In our model, this suggests that $0 < \alpha < 1$. For the seller of the land who finances the buyer, all interest received is taxed at the income tax rate T.

To find the trade-off acceptable to the seller between r^* and V_o^{sf}, the seller-financed land price, we need to include the net after-tax present value of the buyer's interest payments to the seller. To analyze this relationship between V_o^{sf} and r^* for the seller, assume the seller requires downpayment of D percent and thus the loan offered to the buyer is $(1-D)V_o^{sf}$.

To calculate the seller's minimum sell price when offering to finance the buyer, we use all of the assumptions and notations employed in the buyer model. Let V_o^{sf} be the minimum sell price. Assume sV_o^{sf} is the seller's closing fees. Since D percent is paid as a downpayment, only $D[V_o^{sf}(1-s) - V_{o(-t)}^b(1+c)]$ is subject to the capital gains tax at the rate of αT. Finally, assume that $(1-D)V_o^s$ earns interest in perpetuity for the seller. Thus, his or her present value of the interest income equals $(1-D)V_o^{sf}r^*(1-T)/r_f$.

We can express the seller-financed minimum sell price as:

$$-sV_o^{sf} - D[V_o^{sf}(1-s) - V_{o(-t)}^b(1+c)]\alpha T + DV_o^{sf} + \frac{(1-D)V_o^{sf}r^*(1-T)}{r_f} = V_o^b(1+c). \quad (10)$$

Then, solving for V_o^{sf}, we obtain:

$$V_o^{sf} = \frac{[V_o^b - V_{o(-t)}^b \alpha TD]\,(1+c)r_f}{r_f[(D-s) - D(1-s)\alpha T] + (1-D)r^*(1-T)}. \quad (11)$$

Using (9) and (11), we can easily show that each of results 1–5 also hold for the case of seller financing of the land transaction.

We can also use (2), (4), (9), and (11) to explore the effect that capital gains taxes will have on the use of seller financing in the land transaction. First, consider the impact that level of capital gains tax has on seller financing.

RESULT 6. If the seller's loan rate is interest-rate neutral [$r^*(1-T) = r_f$][2], then seller-financed land sales are less (more) likely as the amount of capital gains (losses) increases.

Result 6 can be seen as follows. If seller-financed sales are interest-rate neutral [$r^*(1-T) = r_f$], then using (2), (4), (9), and (11) we see that:

$$\frac{d(V_o^s - V_o^b)}{d\alpha} - \frac{d(V_o^{sf} - V_o^{bf})}{d\alpha} = \frac{(V_o^b - V_{(-t)}^b)\,T(1+c)\,[1/(1-\alpha T)^2 - D/(1-D\alpha T)^2]}{(1-s)} \gtrless 0, \quad \text{as } V_{(-t)}^b \gtrless V_o^b. \tag{13}$$

Finally, consider the effect of a change in the capital gains tax rate on the use of seller financing.

RESULT 7. If the seller's loan rate is interest-rate neutral, then when capital losses (gains) have been experienced, seller-financed land sales are less (more) likely to occur as the capital gains tax rate increases.

Using (2), (4), (9), and (11), we can show result 7 as follows:

$$\frac{d(V_o^s - V_o^b)}{dV_{(-t)}^b} - \frac{d(V_o^{sf} - V_o^{bf})}{dV_{(-t)}^b} = \frac{(1+c)\alpha T}{(1-s)}\left[\frac{D}{(1-D\alpha T)} - \frac{1}{(1-\alpha T)}\right] < 0. \tag{12}$$

When capital losses occur from a sale, seller financing becomes relatively less desirable as the capital gains tax rate increases because it delays the receipt of the tax savings. Similarly, when capital gains are incurred, seller financing becomes relatively desirable because it delays the payment of capital gains taxes. This is consistent with the significant decrease in seller-financed sales following 1986 as seen in Table 1.

Empirical evidence recently observed supports result 6 (see Table 1). As capital losses were incurred in the early 1980s, seller-financed sales as a percent of total sales decreased.[3] The result occurs because seller financing reduced the impacts of capital gains and losses to the seller by delaying the payment of capital gains taxes and the deduction for capital losses.

Summary and Conclusions

This paper presented land-value models for a representative buyer and seller of land. The models are used to explore the conditions under which land is liquid or illiquid. Then the effects that changes in capital gains and losses and the capital gains tax rate have on liquidity are explored. The models are then altered to include seller financing.

The results suggest that decreases in capital gains (or increases in capital losses) should

[2]Interest-rate neutrality refers to the equality between either the after-tax rate of return, r_f, available in the market used or the discount rate and the after-tax interest rate paid on the seller's loan.

[3]From 1982 through 1984, the percentage of credit volume extended by sellers declined from 41% to 28% for the entire United States. During the same time period, the Index of Land Values dropped from 157 to 146 (USDA, various issues).

tend to increase the likelihood of land transactions occurring. Likewise, increases in the capital gains tax rate will decrease the likelihood of transactions when capital gains are involved and increase the likelihood of transactions when capital losses occur. The seller-financing models suggest a decrease in the likelihood of seller-financed land sales as capital gains (losses) decrease (increase). Increases in the capital gains tax rate are shown to increase (decrease) chances of seller financing when capital gains (losses) are present.

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Which Banks Will Participate in Farmer Mac?

Steven R. Koenig and Clifford V. Rossi

Abstract

Participation of financial institutions in the Farmer Mac secondary mortgage market requires the purchase of voting stock in the corporation. Characteristics of commercial banks, the largest class of stockholders, are examined empirically to determine how they might participate in the new market for agricultural and rural-housing mortgages. Geographic concentration of participating banks in the Upper Midwest has important implications for the sensitivity of securities to that region's economic health. Participants are small and specialized in agricultural lending. In general, the favorable financial condition of these firms suggests a stable, but not necessarily large, secondary market.

Key words: secondary mortgage market, agricultural banks, Farmer Mac, commercial bank financial performance.

Many uncertainties remain concerning how the Federal Agricultural Mortgage Corporation (Farmer Mac) secondary mortgage market, authorized over two years ago, might influence the delivery of credit to agriculture and rural areas. Past efforts to examine the market have ranged from detailed reviews of how the market could operate to an empirical estimation of the effects on agricultural lending (Lemieux; Hiemstra, Koenig, and Freshwater; Booth; Barkema, Drabenstott, and Froerer). Yet, the market's effect on farm and rural-housing mortgage rates and terms across the country will depend on the participation of different classes of originators.

This research presents an empirical comparison of the characteristics of Farmer Mac stockholding commercial banks relative to different groups of nonparticipating banks. Specifically, this research investigates which bank characteristics might influence the operation of the secondary market, especially in its infancy. The analysis focuses on agricultural originations rather than rural-housing originations. In addition, a financial profile of participating banks is provided in order to assess the effects of increased competition and diversification of risk on stockholding banks. The financial condition of banks also has important implications for the stability of the marketplace. The analysis employs data from the Board of Governors of the Federal Reserve System's "Report of Condition—Report of Income for Commercial Banks" (Call Report) for June 30, 1989.

Farmer Mac Stockholders

Participation in the new market as either a pooler or an originator requires that a financial entity acquire a specified minimum share of voting common stock in the Farmer

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Mac corporation based on the entity's total asset size (FAMC).[1] Therefore, most originations, at least initially, will come from financial entities that purchased voting common stock at the initial stock offering in December 1988. Poolers can generate their own originations, but since they may initially lack an originations-collecting network, they will likely draw heavily on mortgages from other stockholders.

Farmer Mac was required by statute to divide voting common stock into two classes: Class A and Class B. Class A stock is reserved for non–Farm Credit System (FCS) institutions such as commercial banks and life insurance companies. Class B voting common stock was issued to FCS institutions. At the initial offering, 670,000 shares of Class A stock and 500,301 shares of Class B stock were issued. While no additional stock offerings are planned, such offerings are possible and stock is tradable. It is likely that bank service companies, brokerage firms, and other entities that appear on the stockholders' list purchased stock exclusively for resale purposes.

The majority of Class A stock was sold to insured commercial banks. This makes stockholding banks the primary source for originations along with those generated internally by a pooler or the FCS.[2] With their dominant share of Class A stock, bank participation in the market will have an important impact on the volume, type, terms, and location of Farmer Mac originations.

The importance of bank participation is further supported by the recent sharp rise in farm bank real estate lending. Bank-held farm real estate debt increased nearly 50% from the end of 1985 to the end of 1989, increasing bank share of total farm real estate debt from 10.7% to 20.5% during the period (USDA 1990). This increase occurred while outstanding farm real estate debt was declining for other lenders. Currently, only the FCS holds a greater share of total farm real estate debt.

The number of commercial banks holding stock in Farmer Mac was determined by matching names on the stockholder list supplied by Farmer Mac with banks on the June 30, 1989 Call Report. Through the matching, 1,500 commercial banks were identified as holders of voting common stock.[3] This number far exceeds any other originator group. Savings and loan associations, life insurance companies, federal savings banks, agricultural credit corporations, and mortgage companies were purchasers of stock, but collectively the number of these institutions appears to total less than 100.

A total of 61 multibank holding companies were identified as purchasing voting common stock. This expands the number of banks eligible to originate mortgages (hereafter referred to as "Farmer Mac banks") to 1,929, since these holding companies are parent to 429 member banks. Member banks qualify as originators providing the holding company purchased sufficient stock for its total asset size.[4]

Regional Variation

Farmer Mac banks together represent 15% of all insured commercial banks in existence as of mid-1989. The location and participation rate of Farmer Mac banks varies across the United States (Table 1). As anticipated, states with large agricultural production and small urban populations tend to have the highest percentage of participating banks. Differences in state banking laws concerning branching, multibank holding companies, and interstate banking also likely influence the aggregate numbers and the percentage of participating

[1]Financial entities with total assets of $50 million or less are required to hold 100 shares of Class A Voting Common Stock; $50 million to $100 million in assets, 200 shares; $100 million to $500 million in assets, 500 shares; and over $500 million in assets, 2,000 shares. To qualify as a pooler (Certified Facility), 5,000 shares are required.

[2]While sufficient stock was purchased to allow full FCS participation, its role in the market remains uncertain.

[3]There are eighteen bank names on the stockholder list that do not match names on the Call Report. Bank mergers and failures likely explain much of this discrepancy. Also, the number of bank stockholders as well as other originator types could actually be somewhat higher because an undetermined quantity of stock might have been sold to nominees of the actual holder, thus masking real ownership identity.

[4]This analysis assumes that all holding companies purchased sufficient stock for complete participation by their member banks.

Table 1. Location and Shares of Bank-Held Farm Debts: Farmer Mac Banks

State	Number of Farmer Mac Banks	Share of Total Banks	Share of Total Bank-Held	
			Farmland Secured Debt	All Other Farm Debt
Alabama	3	1.4%	0.5%	0.7%
Alaska	2	25.0	5.2	0.0
Arizona	1	2.2	3.1	0.4
Arkansas	27	10.5	16.8	26.5
California	17	3.6	51.8	56.8
Colorado	82	18.4	46.9	53.5
Connecticut	0	0.0	0.0	0.0
Delaware	3	6.7	11.9	29.8
Florida	4	1.0	16.2	8.6
Georgia	24	6.3	10.1	15.8
Hawaii	0	0.0	0.0	0.0
Idaho	7	30.4	41.9	65.9
Illinois	168	14.9	34.5	34.0
Indiana	48	15.0	23.4	27.5
Iowa	291	50.3	60.3	58.2
Kansas	114	19.8	32.4	35.1
Kentucky	11	3.3	4.7	7.0
Louisiana	16	6.6	28.8	34.0
Maine	1	5.0	24.1	41.3
Maryland	2	1.9	1.1	0.4
Massachusetts	1	1.0	0.0	0.0
Michigan	48	17.1	32.2	33.9
Minnesota	193	29.9	50.8	53.0
Mississippi	15	12.1	21.6	35.1
Missouri	43	7.7	12.0	10.8
Montana	50	29.8	25.3	9.4
Nebraska	188	46.0	62.0	63.8
Nevada	1	5.9	0.0	5.2
New Hampshire	0	0.0	0.0	0.0
New Jersey	0	0.0	0.0	0.0
New Mexico	6	6.5	29.1	36.9
New York	13	6.6	29.2	37.3
North Carolina	2	2.8	18.7	15.8
North Dakota	77	48.4	53.6	52.6
Ohio	40	17.5	23.9	27.8
Oklahoma	40	9.0	17.3	18.9
Oregon	7	14.0	74.8	57.4
Pennsylvania	3	1.0	1.5	1.3
Rhode Island	0	0.0	0.0	0.0
South Carolina	3	3.8	23.6	12.4
South Dakota	60	45.8	51.9	50.9
Tennessee	11	4.1	9.6	9.6
Texas	56	4.0	6.8	11.7
Utah	6	11.1	8.5	10.7
Vermont	2	7.7	20.8	27.0
Virginia	8	4.4	36.1	38.4
Washington	19	20.7	55.3	53.6
West Virginia	0	0.0	0.0	0.0
Wisconsin	172	33.6	49.6	51.7
Wyoming	42	48.3	64.8	60.5
U.S. Total	1,929	15.0%	29.3%	39.2%

banks in a region. Iowa, for example, does not permit interstate banking and limits branching activity (Milkove and Sullivan). Regional differences in the promotion of the Farmer Mac market might provide still another explanation.

Farmer Mac banks are geographically concentrated. The number of stockholding banks is greatest in Iowa, with 291 Farmer Mac banks. Iowa and five surrounding states account for 1,126, or 58%, of the total number of Farmer Mac banks. Moreover, 75% of Farmer Mac banks are located in twelve Corn Belt, Lake, and Northern Plains states. Yet, these twelve states both account for less than 45% of the total farm real estate debt and the total number of U.S. banks. Based on this information, it seems reasonable to conclude that initially these twelve states will be the primary sources of originations from Class A stockholders and that farmers in this region may experience the greatest access to Farmer Mac originations. Just the opposite may be true for farmers in other regions. Six states have no Farmer Mac bank originators, while twelve more states have fewer than 4. These states are mostly in the East, primarily the Northeast.

Farmer Mac banks' current lending volume and their share of total bank agricultural lending provide indicators of their future origination volume. Farmer Mac banks hold 29.3% and 39.2% of the total farmland secured loans and farm production loans held by insured commercial banks, respectively. The 29% share amounts to $4.8 billion in volume. However, this $4.8 billion share represents only about 6% of the total outstanding farm real estate debt at the end of 1988. Keeping in mind secondary markets can encourage originations for banks, this relatively small volume suggests, at least initially, that origination volume from Farmer Mac banks could be limited.

The share of total bank farm loan volume held by Farmer Mac banks varies considerably by region (Table 1). In some states the share exceeds 50%, in other states it is negligible. For example, in Oregon only 14% of that state's banks purchased stock, but they account for 74.8% and 57.4% of the total bank-held farm real estate and production loan volume, respectively. However, when the farmland loan volume is compared to the total farm real estate debt outstanding at the end of 1988, this share drops below 3% (USDA 1989). Obviously, banks play a very minor role in farm real estate lending in that state.

Illinois, on the other hand, had a similar bank participation rate as Oregon, but the share of total bank-held farmland and production loan volume held by Farmer Mac banks was about 34%. Texas and Missouri, with significant agricultural industries, are examples of states where Farmer Mac banks hold a small share of both bank-held farm debt and total farm debt. For Texas, Farmer Mac banks hold just over 1% of that state's total farm real estate debt. Again this indicates that significant regional differences in origination volume could occur at the onset of the market.

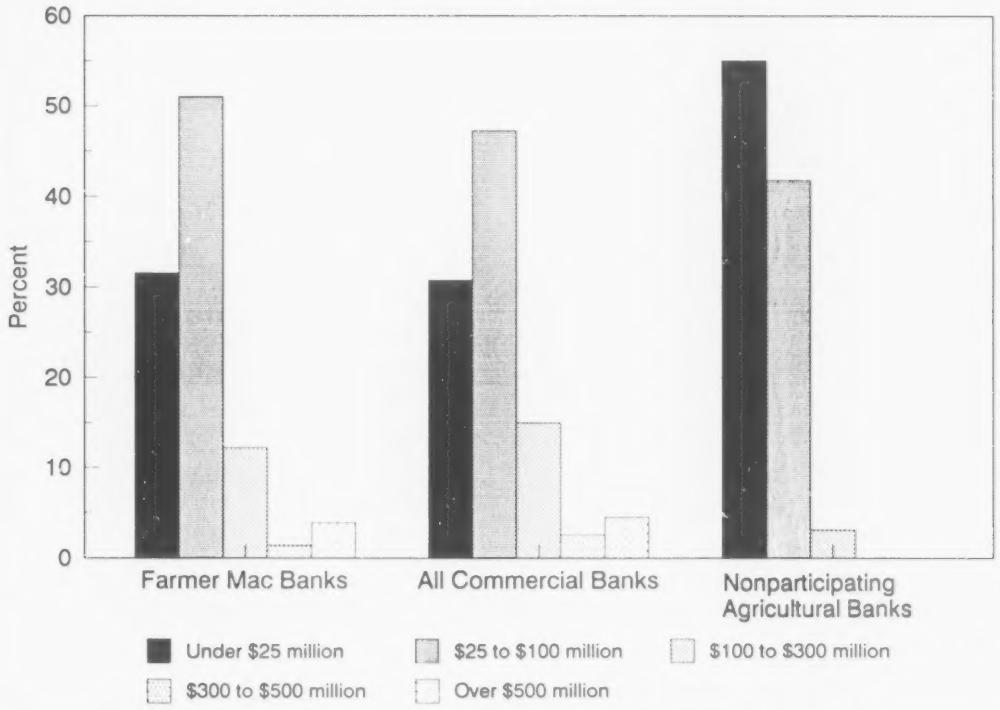
The relatively small volume of farmland debt held by Farmer Mac banks is important to market development because secondary markets require minimal levels of volume, and hence liquidity, in order to price securities competitively with other similar investment instruments. The small volume of banks suggests that, at least initially, there will be few seasoned farm mortgages to draw upon. A small volume from Class A holders would heighten the importance of an active participation by the FCS to achieve market economies of scale. Volume has critical implications for market structure as well, such as the number of poolers that the market can support.

Loan Diversification Standards

Geographical concentration of bank originators and loan volume has implications for Farmer Mac Loan Pool Diversification standards and loan pool structure. These standards stipulate that loan pools must draw upon originations from at least three USDA regions and that no more than 40% of the pool principal come from one region (FAMC).[5] With a high percentage of Farmer Mac banks in the Northern Plains, Lake, and Corn Belt states, at least initially these regions should be the primary source of originations.

[5]Farmer Mac reserves the right to accept pools that do not strictly adhere to this standard if substantial compliance is made and other standards are strongly met.

Figure 1. Distribution of Total Bank Assets by Bank Type, June 30, 1989



The dependence on these regions for originations implies that default rates and prepayment rates (which impact the quality of Farmer Mac securities) will be more sensitive to variations in these regions' farm economy and farm real estate price changes than if originators were more geographically dispersed. Some of the greatest declines in farmland values this past decade occurred in the northcentral states. Moreover, heavy reliance on one region elevates the likelihood that a local natural disaster, such as a drought, will increase default rates and thus negate much of the purpose behind regional diversification standards.

Farmer Mac Bank Profile

In terms of total asset size, Farmer Mac banks resemble the entire U.S. bank population of 12,863 U.S. insured commercial banks (Figure 1).[6] However, Farmer Mac banks are somewhat smaller than the overall bank population. The percentage of banks defined as small (less than $25 million in total assets) is also comparable to all banks.

Large banks, according to Barkema et al., are well positioned to increase market share through the Farmer Mac market. Given this premise, to what extent will a few Farmer Mac banks dominate origination volume? The structure of agricultural loan holdings by asset size provides some insight (Table 2). Small Farmer Mac banks, those under $25 million in total assets, represent 31.5% of all stockholding banks yet account for only 14.2% of bank-held agricultural loans. Banks under $100 million account for 82.5% of all Farmer Mac banks but hold less than 60% of agricultural loans. By contrast, large banks (over $500 million in total assets) make up only 3.9% of the Farmer Mac bank population but have a 24.5% market share. While there appears to be a disproportionate share of agricultural loans held by large participant banks, this does not necessarily mean that the Farmer Mac

[6]Includes domestically chartered banks that are insured by the Federal Deposit Insurance Corporation (FDIC) and have positive values for assets, liabilities, and deposits.

Table 2. Distribution of Agricultural Loans Held by Farmer Mac Banks

Bank Asset Size Category	Proportion of Farmer Mac Banks	Total Agricultural Loans[a]	Category Market Share
Less than $25M	31.5%	$2,393M	14.2%
$25M to $100M	51.0	7,692	45.6
$100M to $300M	12.2	2,454	14.5
$300M to $500M	1.4	198	1.2
Greater than $500M	3.9	4,135	24.5
Total	100.0%	$16,872M	100.0%

[a] Loans secured by farmland plus loans to finance agricultural production.

market will be dominated by a few firms. This conclusion is consistent with Zimmerman who suggests that very large banks do not appear to play a large role in the operation of agricultural markets currently and that there does not appear to be any evidence that Farmer Mac will change that situation.

The large presence of small banks suggests that a significant percentage of bank originations will come from a bank's normal service area, generally within a 20- or 25-mile radius of the bank. Small banks are less likely to originate and service mortgages statewide than larger banks, which have substantial loan staffs and greater lending capacity. Moreover, state bank laws can limit statewide banking practices for large and small banks alike. In states with few Class A originators, this could limit competition for originations.

Farmer Mac banks are located primarily in rural areas. Over 77% of Farmer Mac banks are located in nonmetropolitan counties, compared with roughly 55% for all banks (Table 3). A high percentage of Farmer Mac banks are defined as agricultural banks; that is, they have a ratio of farm loans (real estate and non–real estate) to total loans greater than the unweighted average for all insured commercial banks (Melichar). Seventy-two percent of Farmer Mac banks and 34% of all U.S. banks meet this definition. Therefore, the majority of Farmer Mac banks should be familiar with the specialties of agricultural lending. Also, it is reasonable to conclude that these banks should have a greater commitment to long-term agricultural lending and, hence, participation in the Farmer Mac market than banks with a smaller proportion of their investments in agricultural assets.

Surprisingly, the analysis found the majority of agricultural banks decided not to participate in the program; only 32% of all agricultural banks are Farmer Mac stockholders. Despite this finding, those that anticipate participation are actively involved in agricultural lending. The ratio of total farm production and real estate loans to total loans for Farmer Mac banks was 0.35

Table 3. Selected Bank Attributes by Type of Bank

Bank Attribute	Farmer Mac Banks	Nonparticipating Agricultural Banks	All Insured Banks[a]
Number	1,929	2,926	12,863
Headquartered in Nonmetro County	77%	88%	55%
Affiliated with Multibank Holding Company	35%	19%	31%
National Charter	32%	23%	33%
Average Age of Charter (years)	71	72	72
Average Asset Size ($ millions)	$238M	$32M	$219M
Ratio of Total Loans to Total Deposits	0.62	0.53	1.54
Defined as Agricultural Banks	72%	100%	34%
Ratio of Agricultural Loans to Total Loans	0.35	0.39	0.16

[a] Includes domestic FDIC-insured commercial banks with positive assets, liabilities, and deposits.

Table 4. Secondary Market Activity of Loans With Recourse, by Type of Bank[a]

Market Activity	Farmer Mac Banks	Nonparticipating Agricultural Banks	Nonparticipating Banks
		As a Percent of Total Loans	
Loans Purchased	1.3	3.6	0.9
Loans Sold	2.0	4.4	1.1
Notional Value of Outstanding Interest-Rate Swaps	1.7	0.1	0.2
		As a Percent of Total Residential Mortgages	
Outstanding Principal Balance of Mortgages Sold or Swapped with FNMA & FHLMC[b]	0.8	0.1	0.1

[a] Annualized June 30, 1989 data.

[b] FNMA is the Federal National Mortgage Association and FHLMC is the Federal Home Loan Mortgage Corporation.

compared to 0.39 for nonparticipating agricultural banks. Only 302 Farmer Mac banks, or 16% of the total, report having less than 5% of loan volume devoted to agricultural loans. The typical Farmer Mac bank has an $8.8 million agricultural loan portfolio, whereas nonparticipating agricultural banks have a $5.1 million portfolio.

Individual bank lending policy toward agriculture can be affected by ownership structure, such as affiliation with a multibank holding company (MBHC). A larger percentage of Farmer Mac banks (35%) are affiliated with a multibank parent as compared to all banks (31%) and nonparticipating agricultural banks (19%). Based on this evidence, one might expect Farmer Mac bank lending policy, such as policies toward secondary market participation, to be less locally determined than a typical agricultural bank.

Multibank holding company participation is significant for some states because the majority of the stockholding banks, or in some cases all banks, are members of an MBHC. Therefore, the policies of one parent company with respect to the market could significantly influence the availability of Farmer Mac originations in a particular state or region. For example, twenty-three of the forty Farmer Mac banks in Ohio are members of just three MBHCs; Maine, Nevada, and Arizona each have only one participating bank, all of which are affiliated with out-of-state holding companies.

Secondary Market Participation

The existence of secondary markets offers banks an incentive to sell mortgages because they improve investment-portfolio liquidity. When liquidity is a constraint for bank managers, there is a greater incentive to sell loans. The loan-to-deposit ratio provides a gauge of the lending capacity of the bank and its liquidity position. The ratio for Farmer Mac banks is relatively low at 0.62, suggesting ample lending capacity. This compares to nonparticipating agricultural banks which have a 0.53 ratio and all banks which have a 1.54 ratio. The ratio for all agricultural banks has been less than 0.58 since the last quarter of 1985 (Walraven and Rosine). Liquidity would not seem to be a motivating management factor for bank participation at this time.

The Call Report provides information on bank sales and purchases of loans with recourse. Such information is useful because it serves as a proxy for the sophistication level of the bank and familiarity with loan assets that might be sold but not completely removed from the bank's balance sheet.[7]

As indicated in Table 4, Farmer Mac banks were less active in loan sales and purchases with recourse than nonparticipating agricultural banks. In either case, current sale and purchase activity as a percent of total loans is small, suggesting that many banks may be unfamiliar with these kinds of investment alternatives. However, Farmer Mac banks were slightly more active in

[7] Farmer Mac pools must establish cash reserves or subordinated participation interests (SBI) equal to at least 10 percent of outstanding pool principal. The reserve or SBI might be held by the originator or by the pooler or both, or it could be sold to investors.

interest-rate swaps than nonparticipating banks. This might be explained by the greater volume of residential mortgages and perhaps greater sophistication level associated with a higher concentration of large banks in the Farmer Mac bank category than in the nonparticipating agricultural bank group.

Acknowledging the role demand plays on the amount of variable-rate mortgages held by banks, the reliance on these loans in a bank's portfolio provides some indication of the level of sophistication in bank lending activity. It is hypothesized that the more sophisticated the bank, the better its ability to take advantage of the new secondary market. In particular, Barry and Calvert found the use of floating-rate loans was greater for larger and structurally more complex institutions.

As indicated in Table 5, banks in each of the three groups made more fixed-rate loans than variable-rate loans. However, Farmer Mac banks extended a much higher percentage of variable-rate loan volume than nonparticipating agricultural banks. Note also that the term of fixed-rate loan volume for Farmer Mac banks is more heavily skewed toward longer maturities, particularly over one year, when compared to nonparticipating agricultural banks. Thus, Farmer Mac banks appear to be somewhat more active in long-term and variable-rate lending. One explanation for the low use of variable-rate loans by nonparticipating banks might be the greater use of short-term fixed-rate notes to make interest-rate adjustments on longer-term commitments. Also, nonparticipating agricultural banks may have a larger proportion of their loan portfolios invested in short-term farm operating notes.

Research by Barkema et al. suggests two major effects on institutions participating in Farmer Mac. First, securitization of farm loans is likely to increase competition from new entrants. Profitable banks and those striving for a diversified portfolio are hypothesized to become active participants in an increasingly crowded market. As a result, some experts feel that small specialized local lenders may face an erosion of their competitive advantage as new entrants into the market make their presence felt. To a certain degree a similar scenario was played out in the thrift industry as the securitization of home mortgages increased competition and lowered returns to mortgage lending (Sellon and VanNahmen).

Second, despite the potential for Farmer Mac to increase competition in farm lending, the secondary market should benefit banks dependent on agricultural

Table 5. Outstanding Loan and Lease Maturity and Repricing, by Type of Bank

	Farmer Mac Banks	Nonparticipating Agricultural Banks	Nonparticipating Banks
Type of Loan Interest Rate			
Fixed rate	57.9%	69.7%	54.2%
Variable rate	42.1	30.3	45.8
Total	100.0%	100.0%	100.0%
Distribution of Fixed-Rate Loan Volume by Maturity Class			
3 mo. or less	21.4%	20.9%	14.7%
Over 3 mo. to 12 mo.	13.3	33.7	17.1
Over 1 yr. to 5 yrs.	9.3	33.3	50.9
Over 5 yrs.	26.0	12.1	17.3
Total	100.0%	100.0%	100.0%
Distribution of Variable-Rate Loan Volume by Repricing Frequency			
3 mo. or less	72.7%	72.0%	79.9%
Over 3 mo. to 12 mo.	24.3	27.1	14.5
Over 1 yr. to 5 yrs.	0.9	0.7	5.0
Over 5 yrs.	2.1	0.2	0.6
Total	100.0%	100.0%	100.0%

lending by increasing portfolio diversification through the sale of originations and the purchase of farm mortgage-backed securities (essentially swapping mortgages for securities backed by these mortgages), thereby reducing credit risk that hurt many agricultural lenders during the 1980s. The data suggest that the majority of Farmer Mac bank participants are specialized in agricultural lending and are localized institutions, characteristics that make them particularly vulnerable to variations in the health of local agricultural economies and competition from new entrants.

Financial Profile

The financial condition of Farmer Mac banks merits close scrutiny with regard to profitability and lending activity as the Farmer Mac market develops. While it may be premature to address specific market activity, an analysis of the financial performance of participating banks is presented to offer insight into how these institutions might fare under certain market expectations, such as increased competition.

One measure of bank profitability is the return on equity (ROE). Many banks specializing in agricultural lending witnessed an erosion of their financial health from the farm economy's decline in the mid-1980s. As recently as 1986, agricultural banks on average reported an ROE of just 5% (Walraven and Rosine). By 1989, however, the financial condition of many banks had rebounded sharply.

Among the three classes of banks, the Farmer Mac banks on average maintain a higher ROE (12.3%) than either nonparticipating agricultural banks or nonparticipants in general (Table 6). Moreover, just 3.4% of all Farmer Mac banks experienced a negative ROE in contrast to 5.7% and 10.3% of nonparticipating agricultural banks and all nonparticipant banks, respectively. Return on assets (ROA) figures share a similar pattern as average ROE figures between Farmer Mac banks and nonparticipating institutions.

The net interest margin (NIM) reported by banks is an indicator of a bank's management of interest income over interest expense. Net interest margin for all three classes of banks is lower than the 3.7%–4.0% range experienced for all agricultural banks between 1980 and 1985 (Melichar). Farmer Mac banks reported a

Table 6. Indicators of Bank Profitability, by Bank Type

	Farmer Mac Banks	Nonparticipating Agricultural Banks	Nonparticipating Banks
		Percent	
Average Return on Assets (ROA)[a]	1.1	1.0	0.7
Average Return on Equity (ROE)[a]	12.3	9.0	9.0
Distribution:			
Less than 0%	3.4	5.7	10.3
0% to 3.9%	3.2	4.3	5.2
4.0% to 8.9%	14.3	18.8	15.8
9.0% to 13.9%	39.1	37.8	32.4
14.0% to 18.9%	26.4	22.6	22.9
19.0% to 24.0%	9.4	6.8	8.4
Greater than 24.0%	4.1	4.1	5.0
Total	100.0	100.0	100.0
Ratio of Average Total Primary & Secondary Capital to Total Assets	10.1	10.8	10.5
Distribution:			
Greater than 5.5%	99.0	97.6	96.6
4.0% to 5.5%	0.7	1.4	1.6
0% to 3.9%	0.2	0.9	1.4
Less than 0%	0.1	0.1	0.4
Total	100.0	100.0	100.0

[a] Annualized net income as a percentage of average bank assets/equity.

NIM of 2.1% for June 1989 which was slightly better than the 1.9% NIM experienced by either class of nonparticipating banks. In short, the above statistics indicate that Farmer Mac banks enjoy a slightly better financial performance than their nonparticipating counterparts.

Capital adequacy is an important indicator of a bank's ability to protect itself from unforeseen losses. Farmer Mac banks on average had a slightly lower ratio of total capital to assets than both nonparticipating banks and nonparticipating agricultural banks. For each of the three groups, the vast majority of banks are well capitalized; that is, they have ratios in excess of 5.5%. In fact, fewer Farmer Mac banks have capital-to-asset ratios below 5.5% than either of the other two classes. Whether a bank has adequate capital depends in part upon expected future losses. One way of evaluating losses is to compare the level of nonperforming loans with lending activity.

As a percentage of total loans, average nonperforming loans at Farmer Mac banks were lower than at either nonparticipating agricultural banks and all nonparticipants (Table 7).[8] Also, fewer Farmer Mac banks reported ratios of nonperforming loans to total loans beyond the 5% level than banks in the other two classes.

Farmer Mac banks have a lower average ratio of nonperforming loans to total capital relative to the nonparticipating bank groups. Among Farmer Mac banks, less than 1% are weak (banks having a ratio of nonperforming loans to capital above 100%). On the other hand, 2.8% of nonparticipating banks and 1.9% of nonparticipating agricultural banks are considered weak. The above statistics suggest that, on average, Farmer Mac banks are in sounder financial condition than the other bank categories.

Separating nonperforming loans by loan type in Table 8 reveals that Farmer Mac banks' agricultural loans have a somewhat higher delinquency rate than either real estate or commercial and other loan types. Surprisingly, for nonparticipating agricultural banks the reverse is true. For them, agricultural loan portfolios fare better

[8]Nonperforming loans include those with payments 90 days or more past due and still accruing interest plus those in nonaccrual status.

Table 7. Selected Loan Portfolio Performance Measures, by Type of Bank

Category	Farmer Mac Banks	Nonparticipating Agricultural Banks	Nonparticipating Banks
Ratio of Nonperforming Loans[a] to Total Loans			
Average	2.1%	2.4%	2.4%
Distribution:			
Less than 2.0%	63.4%	59.8%	61.8%
2.0% to 4.9%	27.6	28.4	26.1
5.0% to 9.9%	7.7	9.1	8.9
10.0% to 15.0%	0.9	1.7	2.1
Greater than 15.0%	0.4	1.0	1.0
Total	100.0%	100.0%	100.0%
Ratio of Nonperforming Loans to Total Capital			
Average	12.4%	16.8%	19.5%
Distribution:			
Less than 25.0%	86.1%	85.9%	81.4%
25.0% to 49.9%	10.0	8.8	11.5
50.0% to 74.9%	2.5	2.5	3.1
75.0% to 99.9%	0.5	0.9	1.3
100.0% to 149.9%	0.4	0.8	1.1
150.0% to 200.0%	0.2	0.3	0.5
Greater than 200.0%	0.3	0.8	1.2
Total	100.0%	100.0%	100.0%

[a] Nonperforming loans include those loans 90 days past due and still accruing interest plus those in nonaccrual status.

Table 8. Classification of Nonperforming Loans, by Type of Bank[a]

Loan Category	Farmer Mac Banks		Nonparticipating Agricultural Banks		Nonparticipating Banks	
	Over 90 Days	Non-accrual	Over 90 Days	Non-accrual	Over 90 Days	Non-accrual
	As a Percentage of Total Loans in Each Category					
Real Estate Loans	0.13	0.26	0.76	1.54	0.16	0.32
Commercial and Other	0.24	0.75	1.95	5.16	0.23	0.53
Agricultural Loans	0.61	1.55	0.71	1.96	0.50	1.37
Total Loans[b]	0.37	2.31	0.76	1.61	0.49	2.49

[a] Nonperforming loans include those loans 90 days past due and still accruing interest plus those in nonaccrual status.
[b] Includes loan categories not listed above.

than other loan categories, especially the commercial loan category. This suggests that the nonparticipating agricultural banks do not appear to be particularly adept at making these other types of loans.

Net charge-offs on nonperforming agricultural loans reported by Farmer Mac banks and their nonparticipating counterparts are small—around 0.5%. By comparison, in 1985 almost 57% of agricultural banks had loan losses exceeding 1% of total loans. Loan-loss conditions in 1989 reflect a more favorable economic environment.

Summary Observations on Farmer Mac Bank Participants

The analysis of participating Farmer Mac banks identifies some significant implications for the new market. While larger than the average nonparticipating agricultural bank, Farmer Mac banks focus on agricultural lending and are more rural in their scope of operation than nonparticipating banks in general. The availability of seasoned farm mortgages and new origination volume to pool from commercial banks may be limited at first, suggesting restrictions on the numbers of poolers that may be supported by the market. Geographic location of Farmer Mac banks suggests that availability of and competition for Farmer Mac originations will vary across the country. Moreover, geographic concentration of banks in the Upper Midwest implies that Farmer Mac securities will likely be sensitive to the economic condition of that region.

At present, Farmer Mac banks are well positioned to enter the new market. Financially, Farmer Mac banks have achieved an improvement in performance, fostered in part by a healthier farm economy than existed in the mid-1980s when loan losses soared. Beyond this general improvement in the banking industry, participating Farmer Mac banks exhibit a slightly more healthy financial profile than nonparticipating banks. Less-adaptable and more-specialized participants will need a financial cushion to weather the increased competition the new market is expected to encourage. Despite this potential erosion of earnings, Farmer Mac offers the opportunity to mitigate credit exposure by bundling mortgages and spinning off risk to investors in those pools while continuing to serve the real estate debt needs of their local market. Hence, the general financial integrity of Farmer Mac banks signals a stable, but not necessarily large, source of originations for the secondary market.

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Credit Scoring for a Federal Lending Institution: The Case of Canada's Farm Credit Corporation

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Abstract

This paper discusses and develops a credit-scoring model for Canada's Farm Credit Corporation. Results of logistic regression verify the importance of liquidity, leverage, profitability, efficiency, and debt-repayment capacity as important determinants of default risk. Moreover, the model illustrates how analysis of covariance can be incorporated into a credit-scoring model to account for differences between regions and farm types.

Key words: credit scoring, logistic regression, Farm Credit Corporation.

The Farm Credit Corporation (FCC) is the largest lender of long-term credit to farmers in Canada. As a crown corporation, the FCC is administered by the federal (as opposed to provincial) government and falls within the responsibilities of the minister of agriculture. Although the FCC can make mortgage and other long-term loans to farmers, it cannot accept deposits and is not required to hold equity reserves with the Bank of Canada. The FCC obtains loanable funds from direct equity infusions from the Canadian government or from money markets.

The FCC has for many years been viewed as a lender of last resort, accepting many credit applications which had previously been rejected by commercial lending institutions. Also, because the FCC is a crown corporation, it was also used as a vehicle for federal farm policy. For example, it is within FCC's mandate to provide up to 100% financing for new farm purchases. Liberal lending policies and the invocation of farm policy has put severe strain on the FCC. In 1988–89 the FCC suffered an operating loss of $56.9 million, with an accumulated deficit of $671.2 million (FCC). During this time, 20.1% of its accounts representing $283.5 million were past due. Since 1987 the FCC has reevaluated its goals and objectives, stating that it can no longer be considered a lender of last resort. Rather, its mandate is to provide mortgage credit and complementary financial services to farmers on a break-even basis. Any role involving implementation or administration of federal farm policy is to be on a cost-recovery basis (FCC, p. 5).

The dominant position of the FCC in financing Canadian agriculture has left it vulnerable to the financial risks which

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farmers face. Thus, the FCC must increasingly manage and monitor the risk of its loan portfolio. In 1984 the FCC initiated a risk-management program to analyze farmers' loan loss in order to predict future losses (Fisher). This method uses historical data to assess the default risk on new loans by region and farm type. The model uses farm-specific data on loan amount and security values, but the remaining variables in the model are based on regional data with respect to collateral recovered, nonperforming loans, accounts in default, and uncollectable accounts. However, some important variables relating to profitability, liquidity, efficiency, leverage, debt-repayment ability, and others were excluded. Moreover, the model is used to evaluate the performance of a region's loan portfolio and is not farm specific. Thus, the current method used by the FCC to predict loss accounts may be excluding some important financial and demographic information, which could lead to incorrect predictions.

Given the economic environment under which the FCC must operate, there is a need to evaluate methods to assess the credit worthiness of loan applicants. Models often used to assess credit worthiness are called credit-scoring models. These models are developed through statistical analyses of economic and qualitative variables related to credit worthiness. The intent of these models is to provide lenders with a means to evaluate and manage the risk of loan portfolios. Based upon a prior probability of being an acceptable or a problem loan, a credit score is provided that can be used to classify loan applicants into different credit categories.

The overall objective of this study is to develop and evaluate a credit-scoring model for the Farm Credit Corporation. Following Fischer and Moore, this model should be able to contribute to the FCC's loan-classification system with capabilities to screen loan applications, diagnose credit weaknesses, and price loans based on credit quality. The model should also be based on the following criteria (Fischer and Moore): the credit-scoring function must be accurate enough to contribute to sound lending decisions and valid loan classification, objective in its ability to price loans, simple enough for loan officers to compute and interpret credit scores for screening applicants, and statistically valid. In addition, the model must recognize that the FCC is a federal lending institution with a central administration (in Ottawa). Thus, the model should also consider regional differences in agriculture across Canada's ten provinces as well as differences in farm type.

The remainder of this paper is as follows. First, key variables commonly used in evaluating the probability of agricultural loan defaults will be presented. The next section develops the logistic credit-scoring model to be used in the analyses and discusses the results of the estimated equations. The paper concludes with some comments and recommendations.

Measurements of Loan Default

A substantial number of credit-scoring models for agriculture have in recent years been developed in the United States but no studies have been developed for Canada. The U.S. studies are, in general, regional models. For example, Miller and LaDue estimated functions for a case bank in New York focusing only on dairy farms; Lufburrow, Barry, and Dixon estimated functions for a production credit association in Illinois; Mortensen, Watt, and Leistritz used longitudinal, cross-sectional surveys of a representative sample of farmers from North Dakota; and Fischer and Moore estimated a credit-scoring function for the St. Paul Bank for Cooperatives, which was required for compliance with the rules of the Farm Credit System.

The cited studies, as well as others (see Miller and LaDue, Table 1, p. 27), use similar definitions for key financial variables. In general, variables representing liquidity, leverage, profitability, efficiency, and repayment capacity (Fischer and Moore; Lufburrow et al.; Miller and LaDue), as well as others, are used. However, the selection of model variables across studies has not been consistent (Miller and LaDue). For example, Lufburrow et al. use only liquidity, leverage, collateral, repayment ability, and repayment history; Miller and

LaDue use combinations of profitability, leverage, and efficiency, as do Fischer and Moore; Mortensen et al. use only leverage and efficiency.

This study also defines and tests for significant variables relating to liquidity, leverage, profitability, efficiency, and debt-repayment ability. A sixth category is defined to include regional and farm-type dummy variables to capture the national scope of FCC's loan portfolio. The data variables are defined below. This is followed by a description of the FCC data used.

Liquidity. Liquidity refers to the ability of the farm to meet its fixed financial obligations. The ratio commonly used to measure liquidity is the ratio of current assets to current liabilities (*CR*). A low ratio indicates an excessive amount of current debt relative to current assets. This low working-capital scenario indicates illiquidity in that the farmer may not be able to generate sufficient funds to meet fixed financial obligations. Thus, it is expected that the probability of loan default decreases as liquidity increases.

Profitability. Profitability measures the efficiency of the farm's activities and its ability to generate profit. The variable used in this study is the return on assets (*ROA*). A high ratio indicates investment growth, while a low ratio implies a misuse of resources, which may increase the probability of bankruptcy. It is expected that the probability of loan default decreases as *ROA* increases.

Leverage. Financial leverage occurs when the farm is financed with debt. Three measures of leverage are used in the analyses. First, the debt-to-asset (*DA*) leverage ratio (total liabilities divided by total assets) measures the extent to which the total assets of the farm have been financed using borrowed funds. A high ratio indicates high debt financing and financial risk, which in turn implies a greater chance of bankruptcy than high equity financing. The second measure evaluates risk based on the type of loan (*DLOAN*). This is a binary variable which takes on a value of one if the loan was taken out to refinance or restructure existing debt, and zero otherwise. In some respects, this serves the same function as the repayment-history variable used by Lufburrow et al. It is anticipated that using debt to refinance or restructure loans increases the probability of loan default relative to investment mortgage credit. The third measure is the loan-to-security ratio (*LS*), which indicates the degree by which pledged assets are used as loan collateral. A high loan-to-security ratio is expected to increase the probability of loan default.

Efficiency. The measure of efficiency used in this study is the gross ratio (*GR*), which is defined as the ratio of operating expenses to gross revenue. Since a high value may indicate inefficiencies in input use or production, it is expected that the default risk increases as the gross ratio increases.

Enterprise type and region. Because the FCC is a federal lending institution, its mandate is to provide credit to farmers regardless of farm type or economic region. However, management practices, diversification opportunities, and climatic conditions vary substantially from one province to the other; raising beef cattle in Alberta is quite different than raising beef cattle in Ontario. In recognizing this problem, additional variables will be included to capture the interrelationships between farm type (*TYPE*) and region (*PROVINCE*). This approach incorporates analysis of covariance techniques into a credit-scoring model. There are no a priori expectations about the direction of the estimated covariance relationships relative to the probability of default.

Repayment ability. Repayment ability is measured by two variables in the credit-scoring model. The first is the interest-coverage ratio, which measures the ratio of return on assets to average interest costs. It is anticipated that this variable will have a negative coefficient, indicating that increased coverage implies a decrease in default risk. The second measure used in repayment capacity is the ratio of off-farm income to cash income before interest payments. Since off-farm income is a source of liquidity, it is expected that farmers face lower default risks with increased off-farm income.

The data used in this study were provided

by the FCC from all loan applications made during the 1981, 1982, and 1983 crop years that remained outstanding in 1990. All data pertained to the financial situation of the applicant at the time of application. Three farm classes were defined by the FCC based upon the status of the loans as of March 31, 1990. Class 1 was assigned to all outstanding loans which were current and had never missed a single payment. Class 2 loans were current but had missed one or more payments. Class 3 loans were, at the time of data collection, considered past-due accounts.

Because Class 2 accounts were not overdue, they were grouped with the Class 1 records. Thus, for the credit-scoring model, Class 1 refers to farmers current on their loans and Class 2 refers to loans in arrears.

A Proposed Credit-Scoring Function for the FCC

The FCC is the principal provider of long-term credit to Canadian farmers. As a lending institution, it differs from many of the commercial lending institutions that provide long-term credit to agriculture. The first difference is that the FCC is a crown corporation established to make loans only. All equity and loan funds must be obtained from either the federal government or commercial lending institutions; the FCC is not chartered to accept deposits. The second difference is that the FCC deals exclusively with agricultural loans and, therefore, does not have the opportunities to diversify its loan portfolio in the manner commercial institutions do. Third, the FCC is a national lending institution whose loan portfolio is comprised of many farm types from all regions in Canada.

The first two differences are important in that opportunities for the FCC to diversify or obtain cheap equity funds are severely limited. Thus, relative to commercial lending institutions, the riskiness of its loan portfolio is high, implying that greater accuracy in credit scoring is demanded. The third difference, however, is even more important. The FCC is diversified within agriculture by farm type and region. The importance of this is that different farmers will respond differently to economic signals; some forms of agriculture (e.g., dairy and hog production) are very capital intensive while others are not. Also, there are regional differences that affect FCC loan performance. For example, eastern Canada is much more diversified than western Canada. Hence, economic adversity may have a greater impact on western farmers than eastern farmers such that the riskiness of loans made to western farmers is higher than those made to the eastern farmers.

This study estimates credit-scoring functions using logit regression. This procedure is used because it is simple to compute, easy to understand and use, and provides parameter estimates that are asymptotically unbiased, efficient, and consistent. Alternative credit-scoring models, such as discriminant analysis, linear probability models, and probit models, could have been used (see Chhikara for a review of alternative credit-scoring models). Historically, discriminant analysis (DA) has been popular, however questions have arisen about its econometric properties (DA is neither unbiased nor consistent) and the violation of multivariate normality among the explanatory variables (Collins and Green; Press and Wilson; LaDue). The linear probability model (LPM) has been shown to provide reasonable prediction accuracy relative to DA and logit (Collins and Green). However, the LPM has been criticized (Collins; Pyndick and Rubinfeld; Judge et al.) since there is no guarantee that in- or out-of-sample predicted probabilities will be confined to the unit interval, the variance of the regression is heteroscedastic, parameter estimates may be fragile with respect to sample data (e.g., bunching of observations), and inconsistent estimates invalidate conventional measures of fit such as R^2.

Probit models are similar to logit models but are based on a cumulative normal distribution rather than a cumulative logistic distribution. Both logit and probit provide asymptotically consistent, efficient, and unbiased estimates. In many instances, both models provide near identical results. Thus, given the objective of simplicity in lenders' usage of the credit-scoring model, logit would appear to be best.

The logit model is used to predict the probability that an observed dependent variable that is linearly related to a set of independent variables will fall into the dependent-variable category (e.g., in arrears or not). Specifically, the model formulation is stated as

$$P_i = \frac{1}{1 + e - (Y_i = X'B)}, \qquad (1)$$

where P_i is the conditional (cumulative) probability of the index Y_i occurring, the matrix X corresponds to the cross-sectional values of the explanatory variables, and B is the vector of parameter estimates.

Equation (1) can be estimated using ordinary least squares (OLS) or maximum likelihood estimates (MLE) as

$$\ln\left[\frac{P_i}{1 - P_i}\right] = X'B + \frac{e_i}{P_i(1 - P_i)}, \qquad (2)$$

where e_i is the error term.

The proposed model is designed to capture the covariance between region and farm type. The intent is to provide the FCC with a single-equation model that is simple in structure, form, and interpretation. The model described above will be referred to as the "national model." To determine robustness, the national model will be compared to a "regional model" which restricts the farm-type dummy variables to be equal to zero, a "farm" model which restricts the provincial dummy variables to be equal to zero, and a "basic" model which restricts all dummy variables to be equal to zero.

The general formulation of the national model is described by the linear relationship

$$Y_i = \alpha + \sum_{i=1}^{8} B_i X_i + \sum_{j=1}^{9} DP_j * PROVINCE_j + \sum_{k=1}^{5} DF_k * TYPE_k, \qquad (3)$$

where Y_i is the credit-score index; B_i are scoring weights; X_i ($i = 1, 7$) are critical variables (liquidity, profitability, etc.); DP_j are dummy coefficients (intercept shifters) by province ($j = 1, 9$); $PROVINCES_j$ are dummy variables (1 for province j, zero otherwise); DF_k are dummy coefficients (intercept shifters) by farm type ($k = 1, 5$); and $TYPE_k$ are dummy variables (1 for type k, zero otherwise).

The advantage of this model is that it incorporates analyses of covariance between province and farm type through the interaction between these variables. The effect is that the dummy variables act as intercept shifters and are measured relative to *PROVINCE* 10 and *TYPE* 6. Thus, other things being equal, the credit score will be different for a livestock producer in Alberta and a cash-crop producer in Ontario. The statistical tests involve restricting the national model and estimating the credit-scoring function using provincial dummy variables alone, farm-type dummy variables alone, and no dummy variables. These methods are discussed in the following sections.

Three years of outstanding FCC loans, classified according to their status as of March 31, 1990, were used in the study. In total, 9,403 loan records were made available—2,798 for 1981, 3,167 for 1982, and 3,438 for 1983. The experimental design of the analysis proceeds in the following way. First, the four (restricted and unrestricted) logit models were estimated using data from the 1981–82 crop year. These models were used to test the relevance of region and farm type for the credit-scoring function. Second, the estimated national model for 1981 was used to predict the incidence of current loans and loans in arrears for both the 1982 and 1983 data. Comparing the predicted results to actual results in this way is a validation exercise which checks the robustness of the proposed credit-scoring function. Third, in order to validate and evaluate the model,

the sample frequency of current loans and loans in arrears for all three years was used to establish prior probabilities of loan default (Pyndick and Rubinfeld; Parks; Hensher and Johnson; Miller and LaDue). Of the 9,403 loans, 63% were current and 37% were in arrears. Thus, if the predicted probability exceeded .63, the observation was classified as type 2, otherwise the observation was classified as type 1. It should be noted, however, that the sample proportions differed across the years. For example, the proportions of loans current were 62%, 52.3%, and 73.2% for 1981, 1982, and 1983, respectively. (One should also consider that the proportion of noncurrent loans in the FCC's total loan portfolio in 1989 was only 21%, which is considerably lower than those loans made during the 1981 to 1983 period.) Fourth, parameter stability was evaluated by estimating the national model using 1982 and 1983 data, and comparing these to the 1981 estimates.

Results

This section presents the results of the estimated logit maximum-likelihood estimating equations. The variables included in the model correspond to measures of profitability, leverage, efficiency, liquidity, and repayment ability, and dummy variables for type of loan, province, and farm type. The first part of the section describes the "national" model results and illustrates the use of the covariance relationships between province and farm type in a credit-scoring framework. The second part of the section is used to test the restrictions that the coefficient on the farm-type and regional dummy variables is zero, and presents in- and out-of-sample prediction accuracy tables. The third section presents the estimates for national models using the 1982 and 1983 data.

Table 1. Maximum-Likelihood Estimates of the Logit Credit-Scoring Function[a]

	National		Farm Type		Provincial		Basic	
Variable Name	Parameter Estimates	Asymptotic *t*	Parameter Estimates	Asymptotic *t*	Parameter Estimates	Asymptotic *t*	Parameter Estimates	Asymptotic *t*
Constant	−1.386	−2.84	−0.741	−2.00	−1.640	−3.83	−0.701	−2.28
DA	4.331	13.50	3.835	12.77	4.396	14.14	3.493	12.40
ROA	−2.225	−4.52	−2.325	−4.74	−1.778	−3.71	−1.576	−3.38
LS	0.459	2.16	0.466	2.29	0.361	1.75	0.431	2.24
CR	−0.129	−5.71	−0.113	−5.22	−0.125	−5.65	−0.087	−4.22
IC	−0.186	−1.75	−0.172	−1.64	−0.142	−1.35	−0.078	−0.77
GR	−2.035	−6.32	−1.987	−6.31	−1.969	−6.15	−1.936	−6.21
DLOAN	0.585	6.05	0.488	5.27	0.565	5.99	0.332	3.79
OFI	0.013	0.10	0.029	0.23	0.121	1.11	0.203	1.72
Cash Crop	0.189	0.91	0.466	2.34				
Dairy	−1.234	−5.14	−1.378	−5.90				
Beef	−0.605	−2.12	−0.672	−2.48				
Hogs	0.328	1.36	0.555	2.36				
Poultry	−0.085	−0.37	−0.129	−0.57				
Nfld.	−2.295	−2.96			−2.362	−2.15		
Br. Col.	0.981	2.60			1.216	3.29		
Alberta	1.195	3.69			1.353	4.28		
Sask.	0.850	2.68			1.153	3.76		
Manitoba	0.710	2.18			0.862	2.72		
Ontario	0.150	0.48			0.062	0.20		
Quebec	−0.071	−0.22			−0.347	−1.10		
N. Bruns.	−0.065	−0.15			−0.170	−0.40		
N. Scotia	0.230	0.19			−0.153	−0.12		
Log of Likelihood		−1521.90		−1565.30		−1571.00		−1673.40
Likelihood Ratio		661.140		574.32		562.99		358.06
% Correct Predictions		69.0		67.5		67.8		65.2
Approximate R^2		.21		.19		.19		.12

[a]Provincial dummy variables are relative to Prince Edward Island. Type dummy variables are relative to an "other" category which includes sheep, goats, and specialty crops.

The national model includes the financial measures *ROA, DA, CR, LS, IC, GR, DLOAN,* and *OFI* as well as *PROVINCE* and *TYPE* dummy variables. The estimated logit parameters and asymptotic *t*-statistics are presented in Table 1. Virtually all financial parameters are significantly different from zero at the 5% confidence level. The signs on the parameters conform to expectations, with *ROA, CR,* and *IC* being negative (implying a decrease in the probability of loan default), and *DA, LS, GR,* and *DLOAN* being positive. These results confirm the importance of profitability, liquidity, leverage, and efficiency in credit-scoring models. Also, the results support hypotheses that loan restructuring does not necessarily lead to solvency since loans for restructuring increased the probability of default. Off-farm income was not significantly different than zero.

The farm-type and regional dummy variables are not consistently significantly different from zero, indicating that substantial differences across Canada and across different farm types exist. While the parameter estimates in Table 1 are important, they are best viewed in terms of the relationships between farm type and region. This analysis of covariance approach is exhibited in Table 2.

The values in Table 2 indicate the amount by which the intercept of the logit function will shift given the combined state occurrence of *PROVINCE* and *TYPE*. A positive (negative) value is indicative of an increase (decrease) in the probability of default relative to "other farm types" and the province of Prince Edward Island. For example, a crop farm in Newfoundland (value = −2.11) has a lower probability of default than a hog farm in Newfoundland (value = −1.967). There are also risk differences in farm types due to regional differences. For example, a beef farm in Alberta has a higher probability of loan default (value = 0.589) than a farm of the same type in Ontario (value = −0.455). It is interesting to note that the least-risky farm type is in the dairy sector, which is the most highly subsidized sector in Canadian agriculture and is subject to strict supply controls. It is also interesting that both beef and poultry consistently have a higher probability of loan default in western Canada than in eastern Canada. This information can be used to establish guidelines for targeted financial services by the FCC across Canada.

A chi-square statistic using a likelihood ratio test with 20 degrees of freedom fails to accept the null hypothesis that the parameter estimates for the national model are equal to zero. To test hypotheses about the regional and farm-type dummy variables being equal to zero, three restricted logit regressions were run. The first regression tested the null hypothesis that the coefficients on the farm-type dummy variables were equal to zero, the second tested the significance of the regional dummy variables, and the third tested the hypothesis that both sets of dummy variables were equal to zero. The results of these regressions are presented in Table 1 as farm type, provincial, and basic, respectively. Likelihood ratios measured relative to the national model with degrees of freedom equal to the number of restrictions for a chi-square statistic indicate that all three hypotheses are

Table 2. Covariance Analysis on Farm-Type and Regional Dummy Variables[a]

Region	Cash Crop	Dairy	Beef	Hogs	Poultry
Br. Columbia	1.171	−0.253	0.377	1.309	0.896
Alberta	1.384	−0.04	0.589	1.522	1.109
Saskatchewan	1.039	−0.385	0.245	1.177	0.765
Manitoba	0.899	−0.524	0.105	1.038	0.625
Ontario	0.339	−1.084	−0.455	0.477	0.065
Quebec	0.260	−1.305	−0.676	0.257	−0.156
New Brunswick	0.124	−1.299	−0.670	0.262	−0.115
Nova Scotia	0.419	−1.004	−0.374	0.558	0.146
Newfoundland	−2.11	−3.529	−2.899	−1.967	−2.380

[a]Covariance results are relative to "other" type farms in Prince Edward Island.

rejected; that is, including regional and farm-type dummy variables does contribute to the credit-scoring function. Thus, based on this statistical evidence, using analysis of covariance techniques within a logistic credit-scoring model is justified.

The prediction accuracy of the credit-scoring models is presented in Table 3. Overall, the national model has the best prediction capabilities, with 92% of actual current loans being correctly predicted and 30.8% of actual loans in arrears being predicted. Miller and LaDue define Type I error as classifying a problem borrower as being acceptable and Type II error as classifying an acceptable borrower as a problem. The prediction results suggest that the estimated credit-scoring function has substantial Type I error since 69.2% of problem borrowers were classified (based on the .63 prior probability cutoff) as being acceptable, while only 8% of acceptable loans were misclassified as being a problem (Type II error). However, using prior probabilities to determine Type I and Type II errors may not be appropriate. Instead, Hensher and Johnson suggest that it is appropriate to use posterior probabilities on the ratio of actual cases to predicted cases. Using this method, of the 2,335 observations predicted as current, 1,607 were correct, thus giving 68.8% accuracy (Table 3). The percentage of Type II loans correctly classified using this method is 70.0%. Type I and Type II errors are therefore reasonably symmetric using this measure of accuracy. The overall predictive accuracy of the model, regardless of how the errors are measured, is 69%. The effect of the restrictions on the farm-type and provincial models was a decrease in the overall prediction accuracy. Type I and Type II errors are of the same relative magnitude as in the national model. The accuracy was measured as 67.8%, 67.5%, and 65.2% for the provincial, farm, and basic models, respectively.

The prediction accuracy of the national credit-scoring model using 1982 and 1983 as out-of-sample observations is presented in Table 4. The model correctly predicted only 61.3% of the 1982 data but performed substantially better on the 1983 data with an accuracy of about 74%. Of the total 6,605 observations, 4,483 were correctly classified for an overall accuracy rate of about 68%. As with the 1981 models presented in Table 3, the model does better at predicting which loans will ultimately be current than in arrears; that is, the same relationships

Table 3. Prediction Success of Alternative Logit Credit-Scoring Models for 1981 FCC Loans

	Predicted Current (1)	Predicted Arrears (2)	Observed Count	Observed Share
National Model				
Actual Current (1)	1607	139	1746	.62
Actual Arrears (2)	728	324	1052	.38
Percent Correctly Predicted	68.8	70.0	69.0	
Percent Predicted to Actual	92.0	30.8	69.0	
Provincial Model				
Actual Current (1)	1623	123	1746	.62
Actual Arrears (2)	778	274	1052	.38
Percent Correctly Predicted	67.6	69.0	67.8	
Percent Predicted to Actual	92.9	26.0	67.8	
Farm Model				
Actual Current (1)	1616	130	1746	.62
Actual Arrears (2)	779	273	1052	.38
Percent Correctly Predicted	67.5	67.7	67.5	
Percent Predicted to Actual	92.5	25.9	67.5	
Basic Model				
Actual Current (1)	1658	88	1746	.62
Actual Arrears (2)	887	165	1052	.38
Percent Correctly Predicted	65.2	65.2	65.2	
Percent Predicted to Actual	94.9	15.7	65.2	

Table 4. Prediction of 1982 and 1983 FCC Loans Using the 1981 Logit National Model

	Predicted Current (1)	Predicted Arrears (2)	Observed Count	Observed Share
1982				
Actual Current (1)	1513	143	1656	52.3
Actual Arrears (2)	1083	428	1511	47.7
Percent Correctly Predicted	58.28	74.96	61.29	
Percent Predicted to Actual	91.36	28.3	61.29	
1983				
Actual Current (1)	2194	324	2518	73.2
Actual Arrears (2)	572	348	920	26.8
Percent Correctly Predicted	79.3	51.8	73.9	
Percent Predicted to Actual	87.1	37.8	73.9	

between Type I and Type II errors are carried forward in prediction.

While the 1981 data set provides a reasonably good forecast of the 1982 and 1983 loan applicants, the complete data set provided an opportunity to evaluate parameter stability contingent on the base year for analysis. This is an important consideration since virtually all of the credit-scoring studies cited chose a single year to estimate the scoring function. While the selection of a given year will in no way bias the estimates, it is important to recognize that all of the forecasts for out-of-sample loan applicants are conditional on the status of the farm economy in the base year. For example, in the previous paragraph the 1982 and 1983 forecasts were conditional on the relevant parameters of the agricultural sector present in 1981.

Table 5 presents the estimated logit functions for 1981, 1982, and 1983. The in-sample prediction accuracy is 70.1% for 1982 and almost 80% for 1983. While these are reasonable forecasts, there are some differences in the parameter estimates. For example, the interest-coverage-ratio (*IC*) parameter ranges from -0.186 and -1.145 in 1981 and 1982, respectively, with acceptable levels of significance, to 0.016 in 1983, which is not significantly different than zero. Similarly, off-farm income (*OFI*), which was not significantly different than zero in the 1981 model, takes on moderate to strong significance in the 1982 and 1983 models. Farm and provincial dummy variables also show sign reversals.

These results indicate a caveat, not only for the FCC model presented in this paper, but also for credit-scoring models in general. The parameters of the estimated equations are conditional on the economic environment of the year selected, but the actual outcomes are conditional on events occurring after the loan was made. In Canada, like in the U.S., the 1980s represented fundamental changes in the capital structure and financial viability of the agricultural sector. The most volatile period was in fact the 1981–83 period covered in this study. Many farms which were financially viable and sound in these years faced financial hardships in later years. The unanticipated increase in financial risk throughout the decade may well explain the high Type I error. The question thus arises, "What is a representative year for credit-scoring purposes?" In all probability, a representative year does not exist, which implies that lenders and researchers should be willing to periodically reevaluate, reestimate, and update their credit-scoring models.

Discussion and Conclusions

As a federal lending institution, Canada's Farm Credit Corporation faces great diversity in its loan portfolio due to different types of farmers which make up its client list as well as differences among regions. In recent years, the FCC has declared that it no longer will act in its traditional role as a lender of last resort. Rather, the FCC has committed itself to a more efficient and effective method of

Table 5. Comparing National Credit-Scoring Function Estimates for 1981, 1982, and 1983[a]

Variable Name	1983 Parameter Estimates	1983 Asymptotic *t*	1982 Parameter Estimates	1982 Asymptotic *t*	1981 Parameter Estimates	1981 Asymptotic *t*
Constant	−6.195	−10.33	−2.744	−6.62	−1.386	−2.84
DA	3.818	11.30	5.302	15.80	4.331	13.50
ROA	−5.170	−3.25	−0.258	−0.15	−2.225	−4.52
LS	1.974	7.47	0.693	3.23	0.459	2.16
CR	−0.129	−5.88	−0.138	−6.85	−0.129	−5.71
IC	0.016	0.11	−1.145	−5.19	−0.186	−1.75
GR	2.073	6.46	−0.080	−1.64	−2.035	−6.32
DLOAN	0.561	5.28	0.497	5.34	0.585	6.05
OFI	−0.197	−2.23	−0.893	−1.35	0.013	0.10
Cash Crop	0.583	2.23	0.083	0.42	0.189	0.91
Dairy	−0.766	−2.26	−1.397	−6.03	−1.234	−5.14
Beef	−0.886	−1.49	−0.917	−2.93	−0.605	−2.12
Hogs	0.540	1.77	−0.070	−0.31	0.328	1.36
Poultry	0.319	1.07	0.012	0.05	−0.085	−0.37
Nfld.	0.885	1.04	−0.475	−0.70	−2.295	−2.06
Br. Col.	0.944	2.06	0.872	2.27	0.981	2.60
Alberta	−0.176	−0.40	1.376	3.98	1.195	3.69
Sask.	0.777	1.87	1.025	3.02	0.850	2.68
Manitoba	1.393	3.30	0.808	2.29	0.710	2.18
Ontario	−1.436	−3.34	−0.292	−0.86	0.150	0.48
Quebec	0.045	0.09	−0.267	−0.71	−0.071	−0.22
N. Bruns.	−0.688	−1.00	−0.318	−0.65	−0.065	−0.15
N. Scotia	−0.321	−0.19	−0.586	−0.42	0.230	0.19
Log of Likelihood		−1493.40		−1782.20		−1521.90
Likelihood Ratio		1007.09		819.30		661.14
% Correct Predictions		79.55		70.07		69.00
Approximate R^2		.25		.23		.21

[a]Provincial dummy variables are relative to Prince Edward Island. Type dummy variables are relative to an "other" category which includes sheep, goats, and specialty crops.

assessing loan-default risk. Consistent with these objectives, this paper has developed a national credit-scoring model which accounts for the interrelationships between region and farm type.

The major conclusions of this paper are that measures of profitability, leverage, efficiency, liquidity, and debt-repayment capacity should be combined in a single model of credit risk. This conclusion, however, is not new (Lufburrow et al.), and various studies have used variants of the "basic" model to estimate credit scores (see Miller and LaDue). This paper has contributed to the understanding and estimation of the credit-scoring function by explicitly recognizing regional and farm-type differences. While these interrelationships may not be important for regionally based commercial lending institutions, it is eminently important for federal lending institutions such as Canada's FCC or the United States' federal land banks and Farm Credit System.

Finally, it is important to recognize that credit-scoring functions such as that provided by logit regression are simple enough to be incorporated into the loan review process. For example, since logit provides a closed-form cumulative density function, it can easily be included in a microcomputer program for swift evaluation of a loan applicant. Moreover, since the procedure uses well-known financial ratios which are consistent with the definitions of profitability, leverage, efficiency, liquidity, and debt-repayment capacity, the model can easily be understood by agricultural

lenders. In Canada, where the FCC holds a 40% market share on long-term debt in agriculture, the use of such a model is transparent.

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Are Farm Asset Values Too Volatile?

Scott H. Irwin and Phil L. Colling

Abstract

The research reported in this paper examined the volatility of U.S. farm asset values. Specifically, a variance bounds test was applied to real farm asset returns and values over the 1910–1989 period. The results showed that the standard deviation of actual farm asset values was 2.42 times greater than that of its ex post rational counterpart. Hence, a null hypothesis of excess volatility in farm asset values could not be rejected. Further, the results were not sensitive to alternative assumptions regarding the sample period, discount rate, or terminal value.

Past research on farm asset values has focused primarily on the economic determinants of those values. Included in this literature are studies of the relationship between farm asset returns and farm asset values (e.g., Melichar; Burt; Alston) and the pricing of farm assets within the framework of the capital asset pricing model (e.g., Barry; Irwin, Forster, and Sherrick). The dramatic boom in real farm asset values in the 1970s and the subsequent bust in the 1980s (Figure 1) have focused interest on a different issue. Specifically, the experience of the recent boom-and-bust cycle has led many observers to suggest that farm asset values are more volatile than justified by market fundamentals (e.g., Harl).

Only one study has addressed the issue of excess volatility in the farm asset market. Using a vector autoregression model, Featherstone and Baker found that a one-standard-deviation shock in real farm asset values leads to an overreaction in asset values which take nine years to return to preshock levels. Similar results were obtained for a one-standard-deviation shock in returns. Featherstone and Baker argued that real farm asset values should return to their preshock level immediately in a rational market reacting only to return and interest-rate fundamentals. The fact that values do not react as expected suggests a market with a tendency for over- and underreaction to market fundamentals and hence, excess volatility.

In this paper, the volatility of the farm asset market will be investigated. Specifically, a variance bounds test developed by Shiller (1981) will be applied to real farm asset returns and values over the 1910–1989 period. The variance bounds test places a theoretical limit on the variance of a price series given the variance of a return series. Since the variance bounds test is derived

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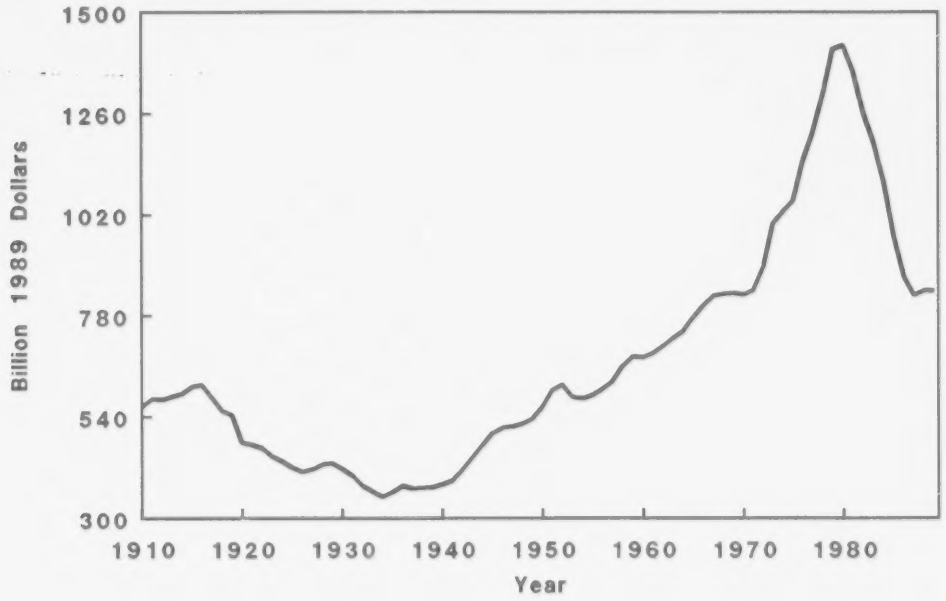
Figure 1. Farm Asset Values, 1910–1989



from a formal theoretical model of an efficient asset market, a direct and rigorous test of the excess-volatility hypothesis is possible.

The next section presents the efficient-market model and resulting variance bounds test. Following sections present the data, results, and summary and concluding remarks.

The Efficient-Market Model and the Variance Bounds Test

The efficient-market model and variance bounds test developed by Shiller (1981) will be presented in this section. Notation will be changed slightly so that it pertains to asset values and income from assets rather than stock prices and dividends.

A simple efficient-market model of the value of an asset A at the beginning of time t is given by

$$A_t = \sum_{k=0}^{\infty} \tau^{k+1} E_t I_{t+k}, 0 < \tau < 1, \quad (1)$$

where E_t is the mathematical expectation conditional on information at time t, I_t is income from that asset during time t, and τ is the constant real discount factor. The constant real discount rate is r so that $\tau = 1/(1 + r)$. The discount rate is assumed to be risk adjusted and determined by an equilibrium risk-return model such as the capital asset pricing model (Sharpe; Lintner; Mossin). At time t, known information will include at least A_t, I_t, and their lagged values.

To ensure stationarity of the return and asset-value series, any trend growth must be removed from the series. Hence, the asset-value and income series can be written in terms of the long-run growth factor α:

$$a_t = A_t/\alpha^{t-T}, \quad (2)$$
$$i_t = I_t/\alpha^{t-T}. \quad (3)$$

The growth factor is $\alpha^{t-T} = (1 + g)^{t-T}$, where g is the rate of growth and T is the base year. The exponential growth path is estimated by regressing the natural logarithm of asset values on a constant and time. Then α in (2) and (3) is set equal to e^b, where b is the coefficient of time from the regression. Model (1) can be rewritten

in terms of detrended series by dividing all terms of that model by α^{t-T}:

$$a_t = \sum_{k=0}^{\infty} (\alpha\tau)^{k+1} E_t i_{t+k}$$

$$= \sum_{k=0}^{\infty} \lambda^{k+1} E_t i_{t+k}, \qquad (4)$$

where $\lambda = \alpha\tau$ is the discount factor associated with this model for the detrended series.

In order for the efficient-market model to give a finite price, the growth rate must be less than the discount rate. The discount rate for the detrended series (r) is defined by $\lambda \equiv 1/(1 + r)$. If we take unconditional expectations of both sides of (4) we get $E(a) = (\lambda/(1 - \lambda))E(i)$. Upon substituting $1/(1 + r)$ for λ and solving, we find that $r = E(i)/E(a)$. In other words, the appropriate discount rate and the rate used for the variance bounds test are equal to the mean of the detrended income-from-assets series divided by the mean of the detrended asset-value series. As indicated earlier, the estimated discount rate is assumed to be risk adjusted.

At this point, an ex post rational asset-value series can be constructed. The idea is to construct a series of asset values, a_t^*, which would have occurred if market participants had known precisely what income in all future years would be and if they had perceived the constant real discount rate discussed above. In this case, a_t^* is the present value of actual income from assets. This model is

$$a_t = E(a_t^*), \qquad (5)$$

where $a_t^* = \sum_{k=0}^{\infty} \lambda^{k+1} i_{t+k}$.

Notice that with this model, the conditional expectations operator has been dropped. Because the summation extends to infinity, the ex post rational series a_t^* can never be observed without some error. However, with a series for income from assets that is fairly long, we can observe an approximate ex post rational series. After assuming a terminal value for a_t^* (usually the average asset value of the series), the previous values of the series can be computed recursively by

$$a_t^* = \lambda (a_{t+1}^* + i_t). \qquad (6)$$

To derive the variance bounds test it is useful to briefly review the concept of an optimal forecast (Shiller 1988). The definition of an optimal forecast of a variable is its mathematical expectation conditioned on all available information. An optimal forecast must have a variance less than or equal to the variance of the variable being forecast. In other words, the variance of the conditional mean of a distribution is less than that of the distribution itself.

To begin the derivation, note that equation (5) implies a_t is the mathematical expectation of a_t^*, conditional on information at time t. As noted above, this is the definition of an optimal forecast. Next, define the forecast error as

$$\mu_t = a_t^* - a_t. \qquad (7)$$

For a_t to be an optimal forecast, the covariance between a_t and μ_t must be zero. Since the variance of the sum of two uncorrelated variables is the sum of their variances,

$$\text{var}(a_t^*) = \text{var}(\mu_t) + \text{var}(a_t). \qquad (8)$$

Since $\text{var}(\mu_t)$ must be nonnegative, (8) implies that

$$\text{var}(a_t) \leq \text{var}(a_t^*). \qquad (9)$$

Stated in terms of standard deviations, the inequality becomes

$$\sigma(a_t) \leq \sigma(a_t^*), \qquad (10)$$

which is the variance bounds test.

Data

The data used in this study are U.S. aggregate farm asset values and income from farm assets for the period 1910 to 1989. The source for the data from 1910 to 1970 is the June 1987 issue of the

Agricultural Finance Databook published by the Federal Reserve System. The data for the remainder of the sample period were furnished by the Economic Research Service of the U.S. Department of Agriculture and include the latest revisions as of May 1990.

The income-return and asset-value series were converted to 1989 dollars via the personal consumption expenditure deflator. To obtain stationarity, the data were detrended. The exponential growth path of asset values was estimated by regressing the natural logarithm of asset values on a constant and time. Then α in (2) and (3) was set equal to e^b, where b is the coefficient of time from the regression. The detrended series for asset values and income from assets were then computed from (2) and (3). The constant real discount rate was set equal to the average of detrended income from assets divided by the average of detrended asset values. These statistics appear in Table 1.

Results

The detrended farm asset value series and the ex post rational asset value series appear in Figure 2. The ex post rational series was computed recursively from (6), with the terminal value for a_t^* set equal to the average of detrended asset values over 1910–1989 ($1,067.4 billion). Figure 2 shows that the ex post rational asset value series, a_t^*, is smoother than the detrended actual series, a_t. While there were years when income from assets was very high or low (Figure 3), these times did not last long enough to cause the ex post rational series to move significantly. In contrast, a_t has been quite volatile at times. This seems to be especially true during the 1930s and from the early 1970s to the mid-1980s.

Important assumptions in deriving the ex post rational asset value series are the discount rate and the terminal value. If a different discount rate had been chosen but the terminal value remained the same, the recursive relationship (6) would cause the new ex post rational price to move further from the original series as we move away from the terminal date. The results of adding and subtracting .01 from the sample discount rate (.0404) are shown in Figure 4, with the middle curve representing the same ex post rational series as in Figure 2. If a different terminal value had been chosen but the discount rate remained the same, the effect would have been to add or subtract an exponential trend to or from ex post rational prices. Figure 5 shows the effect on the ex post rational series of adding and subtracting $150 billion to the assumed terminal value ($1,067.4 billion), where the middle curve is again the same as in Figure 2.

Sample statistics relevant to variance bounds inequality (10) appear in Table 2. Statistics are presented for six scenarios to test the sensitivity of the results to alternative assumptions regarding the sample period, discount rate, and terminal value. Statistics in the first scenario are based on the full 1910–1989 sample period as outlined above. Since the standard deviation of a_t is 2.42 times greater than that of a_t^*, the variance bound inequality is violated.

The second scenario is based on the same assumptions as the first, except that the boom and bust of the 1970s and 1980s is excluded from the sample. Despite exclusion of the most-volatile period in the sample, the standard deviation of actual farm asset values is 2.06 times that of its ex post rational counterpart, and again the variance bounds inequality is violated. The final four scenarios alter the discount rate or terminal value assumption for the full 1910–1989 sample period. In all of these scenarios, the variance bound inequality continues to be violated.

Table 1. Sample Statistics for Farm Asset Income and Value, 1910–1989

$E(a)$	Average Detrended Asset Value (billion 1989 dollars)	$1,067.4
$E(i)$	Average Detrended Income from Assets (billion 1989 dollars)	$43.1
r	Constant Discount Rate	.0404
$b = \ln(\alpha)$	Slope of Time Coefficient	.0128
$\hat{\sigma}(b) =$	Standard Error of b	.0016
R^2	Coefficient of Determination for Trend Regression	.6092

Figure 2. Farm Asset Values and Ex Post Rational Values (Detrended), 1910–1989

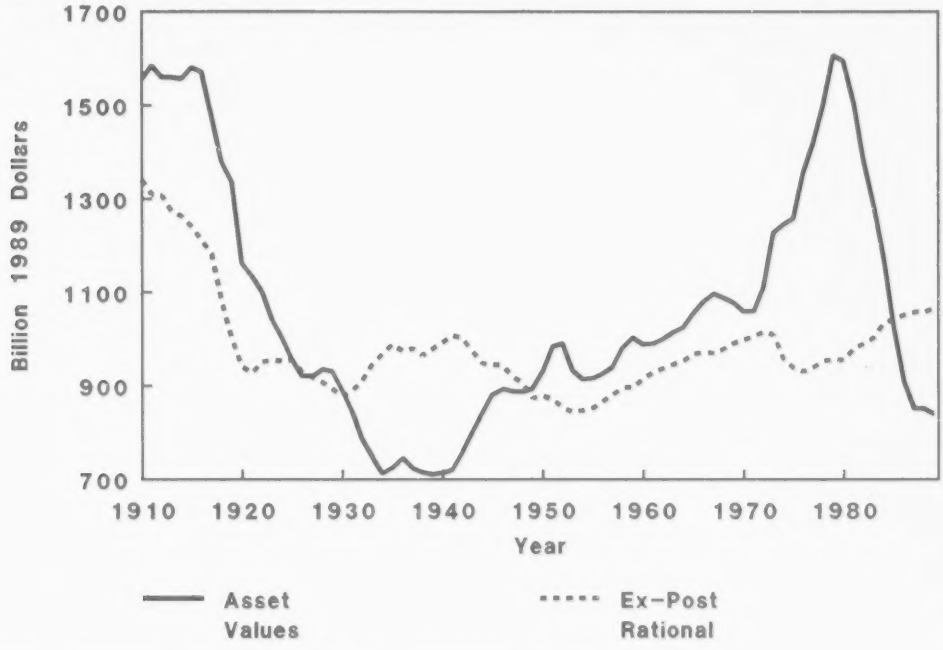
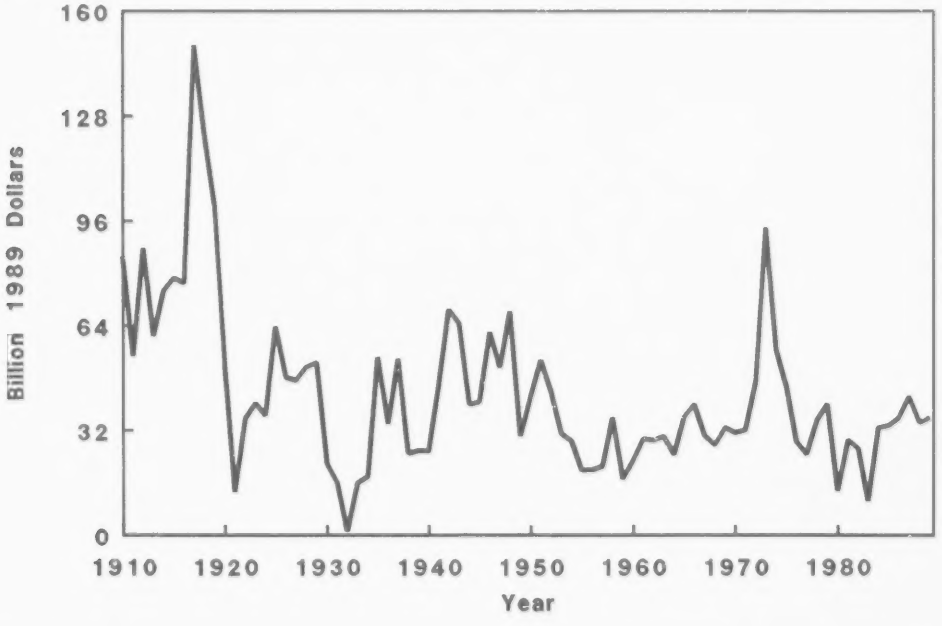


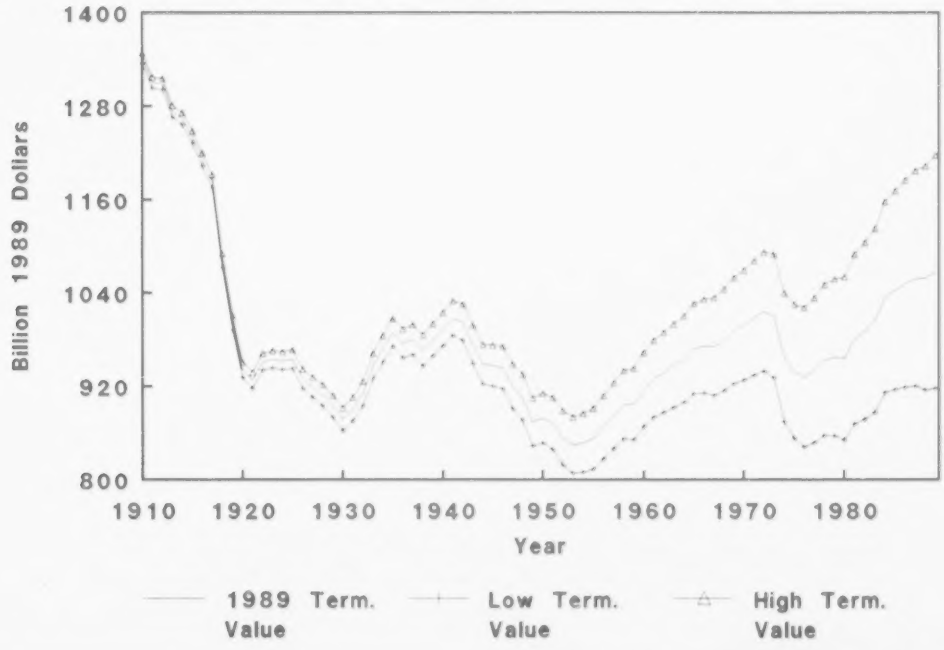
Figure 3. Income from Farm Assets (Detrended), 1910–1989



In sum, the null hypothesis of excess volatility in farm asset values cannot be rejected based on the test procedures and data used in this paper. Further, the conclusion does not appear to be sensitive to alternative assumptions regarding the sample period, discount rate, or terminal value.

Figure 4. Effect of Different Discount Rates on Ex Post Rational Values

Figure 5. Effect of Different Terminal Values on Ex Post Rational Values



It is interesting to compare the results from farm asset values and the stock market. Shiller (1981) found that the Dow Jones Industrial Series for the stock market from 1928 to 1979 had a standard deviation thirteen times greater than that of its ex

Table 2. Variance Bounds Inequality Statistics for Farm Asset Values

Scenario	$\sigma(a_t)$	$\sigma(a_t^*)$	Ratio
		Billion 1989 $	
Sample: 1910–1989	266.3	109.8	2.42
Sample: 1910–1970	254.5	123.6	2.06
Low Discount Rate:[a] 1910–1989	144.7	109.8	1.84
High Discount Rate:[b] 1910–1989	116.2	109.8	2.29
Low Terminal Value:[c] 1910–1989	119.0	109.8	2.24
High Terminal Value:[d] 1910–1989	114.6	109.8	2.32

Note: $\sigma(a_t)$: standard deviation of farm asset values; $\sigma(a_t^*)$: standard deviation of ex post rational farm asset values; ratio: $\sigma(a_t)/\sigma(a_t^*)$.

[a]Discount Rate = .0304.

[b]Discount Rate = .0504.

[c]Terminal Value = $917.4 billion.

[d]Terminal Value = $1,217.4 billion.

post rational counterpart. The explanation for the relatively low volatility of the farm asset value series likely is due to the fact that a_t actually tracked a_t^* fairly closely for a large number of years and diverged from it substantially only during certain times (during the 1930s and from the early 1970s to the mid-1980s). In contrast, Shiller's Dow Jones Series was rarely close to its ex post rational counterpart. Further, the difference in results also may be related to the fact that companies try to "smooth" dividends over several years despite the fact that earnings may be quite variable. This is discussed in Shiller (1981, 1986), Marsh and Merton, and Kleidon. Because of this smoothing process, dividends will tend to be fairly stable when compared to income from farm assets.

Summary and Concluding Remarks

The research reported in this paper examined the volatility of U.S. farm asset values. Specifically, a variance bounds test developed by Shiller (1981) was applied to real farm asset returns and values over 1910–1989. The variance bounds test places a theoretical limit on the variance of a price series given the variance of a return series. Since the variance bounds test is derived from a formal theoretical model of an efficient asset market, a direct and rigorous test of the excess-volatility hypothesis is possible.

The results showed that the standard deviation of actual farm asset values was 2.42 times greater than that of its ex post rational counterpart. Hence, the null hypothesis of excess volatility in farm asset values could not be rejected. Further, the results were not sensitive to alternative assumptions regarding the sample period, discount rate, or terminal value.

There are several possible explanations for the results that are consistent with market efficiency. First, discount rates may not be constant. As a result, time-varying discount rates may explain the observed excess volatility. Second, Grossman has argued that excess volatility is in fact the expression of a sophisticated dynamic trading strategy used by relatively uninformed traders. These traders have rational expectations, but because they are relatively uninformed, they must infer information about underlying fundamentals from price movements themselves. If price changes because of changing risk preferences of informed traders, ex post excess volatility may be the result of rational mistakes in the assessment of underlying fundamentals by the uninformed traders.

Third, Shiller (1988) has argued that a small probability of a disaster or windfall may explain the observed excess volatility. New information may evolve from year to year that causes changes in the probability assessment of the disaster or windfall. However, the information has little to do with observed movements in returns.

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Tax Reform, Rural Community Banks, and Municipal Bonds

Jeff P. Boone and Clair J. Nixon

Abstract

This study examines the impact of current and proposed changes in the alternative minimum tax on the rural community bank holdings of municipal bonds. Trends in the federal tax law encourage shifting of community-bank investment portfolios away from municipal bonds to taxable bonds. Portfolio shifting will likely cause an increase in funding costs with a resultant decrease in rural-community capital-development projects.

Municipal bonds are an important source of financing for rural capital-investment projects. Community banks have typically been the major institutional supplier of funds for these municipal bonds.[1] These banks are motivated to purchase municipal bonds for two reasons. First, the banks are in search of high after-tax yields. The tax-exempt status of municipal bonds from federal income tax has made them attractive investment vehicles for banks and individuals. Second, community banks are key "pillars" in the rural community. They purchase bonds because of political and public-image considerations arising from the community's expectancy that the local bank will "take its share" of any new local issue of municipal bonds (Sheppard). Community-bank investment portfolios also frequently include a higher percentage of municipal-bond holdings than do their noncommunity-bank counterparts (Neubig and Sullivan).

Yet, income-tax provisions enacted through the Tax Reform Act of 1986 effectively created a financial disincentive for community banks to increase or even maintain their holdings of municipal bonds. The introduction of the corporate alternative minimum tax and the role of tax-exempt income in its calculation have effectively depressed the after-tax yields on municipal bonds to the community bank. Further depressing the after-tax yields on municipal bonds is the elimination, as a tax deduction, of the interest expense incurred to finance the purchase and carrying of these bonds. Because community-bank demand for local municipal bonds

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[1]For the purposes of this study, a community bank is a nationally chartered, rural, agriculturally based bank with total assets between $100 million and $200 million. These banks generally serve smaller communities and their rural clients.

historically has been a substantial constituent of an aggregate market demand for the bonds, any significant reduction in bank demand for bonds implies an increase in borrowing costs, an impairment in borrowing ability, or both, for rural-community governments.

Congress, concerned about the adverse potential effect of tax reform on small local governments, exempted bank holdings of municipal bonds issued by a "qualified small issuer" (QSI) from the interest expense deductibility disallowance provision.[2] The term "qualified small issuer" was carefully defined by Congress to primarily encompass small local governments. As a result of this exemption, the after-tax yields earned by community banks on QSI bonds remained sufficiently attractive following tax reform to induce bank purchases. This financial symbiosis between community banks and small local governments continued following tax reform. However, recently enacted legislation, as well as proposed legislation, may adversely affect this relationship.

The purpose of this study is to examine, through the use of an economic bank model, the impact upon a representative community bank of both enacted and proposed changes in the alternative minimum tax. The results have important implications for the ability of these banks to continue in their traditional role of significantly financing rural-government capital investments through municipal-bond purchases.

Bank Demand for Municipal Bonds

Bank demand for investment securities is believed to be residual in nature, meaning that banks will first fund loan demand, required reserves, and primary reserves before purchasing investment securities (Silber). Hendershott and Koch hypothesize that bank residual funds will be allocated between municipal bonds and alternative taxable investment securities so as to maximize after-tax yields. Prior to the introduction of the corporate alternative minimum tax, banks could maximize their after-tax profits by basing their investment-portfolio selection on pretax tax-exempt yields as compared to after-tax yields on non-tax-exempt securities. After 1986, however, the federal income tax provisions, which, in part, determine the yield earned by a bank on a municipal security, are (1) the alternative minimum tax and (2) the interest-expense-disallowance provision. These provisions are discussed in detail below.

Tax Treatment of Municipal Bond Interest Income and the Alternative Minimum Tax

After 1986, all banks compute their tax liability under the regular tax rates and the alternative minimum tax, paying the greater of the two. This procedure ensures that profitable banks will pay at least a minimum amount of tax. Prior to 1987, many profitable banks avoided paying federal income taxes through investment in tax-preference items, such as tax-exempt securities. The corporate alternative minimum tax, however, has a much broader income base than the regular income tax, thereby decreasing a bank's potential for federal income tax avoidance.

Unlike regular taxable income, alternative minimum taxable income includes tax-exempt interest income earned on municipal bonds. Through 1989, the effect of tax-exempt interest was included in alternative minimum tax through the "book untaxed reported profits" (BURP) adjustment. Here, 50% of financial-statement earnings (including tax-exempt interest income) not included in regular taxable income were added to the alternative minimum taxable income. With the largest component of a community bank's financial-statement earnings not yet included in regular taxable income being tax-exempt interest, banks subject to the alternative minimum tax were effectively taxed on 50% of their tax-exempt interest.

[2]Internal Revenue Code Section 265(b) disallows as an income-tax-deduction interest expense allocable to tax-exempt interest income. However, IRC Section 265(b)(3) exempts "qualified tax-exempt obligations" from the application of IRC Section 265(b). IRC Section 265(b)(3) defines "qualified tax-exempt obligation" as public-purpose bonds issued by a government which reasonably expects to issue no more than $10 million of such bonds in any one year.

For tax years beginning after December 31, 1989, the BURP adjustment is replaced by the adjusted-current-earnings (ACE) adjustment. The ACE adjustment will be similar to the BURP adjustment, except that ACE will include 75% of tax-exempt interest income in alternative minimum taxable income.

Proposed legislation (H.R. 1761) would further increase a profitable community bank's exposure to the alternative minimum tax by repealing the ACE adjustment and creating a 100% adjustment (direct) for tax-preference items. This would result in the inclusion of all tax-exempt interest earned by a bank in the alternative minimum taxable income. While this proposal was not accepted by Congress in 1989, there is a strong possibility that such legislation will be reintroduced during 1990.

Interest Expense Deductibility Disallowance

Following tax reform, interest expense allocable to a bank's municipal-securities portfolio is disallowed as a tax deduction, except for interest expense allocable to a QSI bond. Eighty percent of the interest expense allocable to a QSI bond may be deducted by a community bank. However, all municipal bonds owned by the bank prior to the effective date of tax reform are grandfathered, so that the bank can continue deducting interest expense allocable to these bonds to the extent permitted under prior law.

The marginal after-tax carrying cost of municipal bonds produced by eliminating the deductibility of allocable interest expense causes the after-tax yields to fall below those earned on taxable securities, assuming a taxable/tax-exempt interest-rate spread within recent historical ranges (Table 1). With QSI bonds, for which a community bank is allowed to deduct 80% of the interest expense allocable to the bonds, the after-tax yields currently earned are generally greater than those earned on comparable taxable securities. If the trends exhibited in Table 1 continue, there is a disincentive for the community bank to hold any bonds other than QSI bonds.

Table 1. Taxable and Tax-Exempt Rates, January 1987–January 1989

Date	Taxable Rates	Tax-Exempt Rates	Ratio of Exempt to Taxable
1/87	7.60%	6.12%	0.81
2/87	7.69	6.05	0.79
3/87	7.62	6.25	0.82
4/87	8.31	7.20	0.87
5/87	8.79	7.61	0.87
6/87	8.63	7.48	0.87
7/87	8.70	7.18	0.83
8/87	8.97	7.24	0.81
9/87	9.58	7.66	0.80
10/87	9.61	7.90	0.82
11/87	8.99	7.50	0.83
12/87	9.12	7.45	0.82
1/88	8.83	7.29	0.83
2/88	8.41	7.05	0.84
3/88	8.61	7.20	0.84
4/88	8.91	7.33	0.82
5/88	9.24	7.56	0.82
6/88	9.04	7.51	0.83
7/88	9.20	7.50	0.82
8/88	9.33	7.51	0.80
9/88	9.06	7.39	0.82
10/88	8.89	7.25	0.82
11/88	8.89	7.25	0.82
12/88	9.07	7.35	0.81
1/89	9.13	7.35	0.81
2/89	9.07	7.23	0.80
Average	8.82%	7.25%	0.82

Source: *Federal Reserve Bulletin*

For community banks paying the regular corporate income tax, the after-tax yield of a municipal bond is determined as follows:

$$ATY = i_e - (i_d * u * b), \quad (1)$$

where ATY is the after-tax yield on the municipal bond; i_e is the pretax yield on the municipal bond; i_d is the average cost of funds per asset; u is the corporate marginal tax rate; and b is the interest-expense-disallowance percentage.

Equation (1) shows that the after-tax yield earned on a municipal bond equals the pretax yield reduced by the tax effect of the disallowed interest-expense deduction. For a bank subject to the alternative minimum tax, the after-tax yield of a municipal bond is

$$ATY = \{i_e * [1 - (m * c)]\} + (i_d * m * b * c), \quad (2)$$

where i_e is the pretax yield on the

municipal bond; m is the alternative minimum marginal tax rate; b is the interest-expense-disallowance percentage; c is the inclusion percentage under BURP, ACE, and H.R. 1761; and i_d is the average cost of funds per asset.

Equation (2) shows that the after-tax yield earned on a municipal bond equals the pretax yield reduced by the tax effect of taxing a portion of the municipal interest income. Since the after-tax yields of tax-exempt securities decline less than those of taxable securities for a given increase in federal income tax rates, the benefits of holding tax-exempt securities increase (decrease) relative to taxable securities when the regular or alternative minimum tax rates increase (decrease).

Break-Even Yield Ratios

The ratio of market pretax yields on tax-exempt securities relative to the market pretax yields on taxable securities, whenever the after-tax yields of both are equal, is termed the break-even yield ratio. Given the presence of both the regular tax and alternative minimum tax, two break-even ratios will exist for any community bank: one when facing the regular tax and another when facing the alternative minimum tax. By rearranging equations (1) and (2), and dividing them by i_t, the interest rate on taxable securities, after-tax and break-even formulas are derived by integrating all relevant tax considerations in the Tax Reform Act of 1986. The ratios are further expanded to accommodate changes under both the ACE and H.R. 1761 adjustments.

$$\text{Regular Tax: } i_e/i_t = 1 - u[1 - b(i_d/i_t)]. \quad (3)$$

$$\text{Alternative Minimum Tax: } i_e/i_t = \{1 - m[1 - (c)(b)(i_d/i_t)]\}/[1 - (c)(m)]. \quad (4)$$

The break-even ratios, assuming that $i_d/i_t = 0.625$, yielded by equations (3) and (4) for the BURP, ACE, and H.R. 1761 adjustments under both regular and alternative-minimum-tax scenarios are shown in Table 2.[3] A comparison of Tables 1 and 2 shows that, on average, the market rate was insufficient to induce bank purchases under any scenario except that of a bank which was not subject to the alternative minimum tax and which purchased qualified small issue bonds.

Previous studies have shown that under conditions of certainty, the profit-maximizing mix between taxable securities and tax-exempt securities occurs when the alternative minimum tax is equal to the regular tax.[4] Yet, because the profit-maximizing level of investment in municipal bonds is a function of many bank-specific factors, it is difficult to generalize about the effect upon municipal-bond investment of, say, a change in the percentage of tax-exempt interest income included in alternative minimum taxable income. However, a bank model, which simulates a "typical" community bank, provides the basis for analyzing the effect of changes in alternative income and investment variables.

[3]A more complete discussion of the derivation of equations (3) and (4) can be found in Neubig and Sullivan.

[4]The profit-maximizing mix will occur when the regular tax equals the alternative minimum tax, assuming that tax-exempt yields relative to taxable yields are, before imposition of the alternative minimum tax, greater than the break-even yield ratio, and that tax-exempt yields relative to taxable yields are less than the break-even yield ratio after imposition of the alternative minimum tax.

Table 2. Effects on the Break-Even Yield Ratio of BURP, ACE, and H.R. 1761

	Break-Even Yield Ratios		
Item	50% BURP	75% ACE	100% H.R. 1761
Regular Tax			
20% Interest Disallowance	0.700	0.700	0.700
100% Interest Disallowance	0.870	0.870	0.870
Alternative Minimum Tax			
20% Interest Disallowance	0.900	0.960	1.030
100% Interest Disallowance	0.960	1.050	1.160

Simulation Model

The simulation model used in this study is BANKMAN (Duncan). This model is capable of simulating the effects upon a representative community bank of operating-environment changes, both internally and externally imposed, over a four-year period. The community bank is used because of the important role it plays in financing local-government investment, as shown by the relatively high level of municipal-bond holdings. Beginning asset and liability characteristics and values for the representative community bank represent the mean December 31, 1985 balance sheets of independent, nationally chartered, community commercial banks with total assets between $100 million and $200 million and a ratio of agricultural loans to total assets between 10% and 40% (Table 3). The model simulates bank investment decisions based upon risk/return-preference considerations, with asset and liability pricing based upon spreads off a specified U.S. Treasury yield curve. The yield curves of the period 1986–89 are the assumed interest-rate scenario for the simulation period. The model further incorporates a constant tax-exempt/taxable yield ratio of 0.82. Purchases and sales of municipal bonds are based upon Hendershott and Koch's model of profit maximization as extended by Neubig and Sullivan and include only qualified small issue bonds. These bond transactions are further constrained by loan demand and reserve requirements.

The model simulates bank operations for the period 1990–93 under three scenarios which differ only in the assumed tax policy. Scenario one, incorporating the BURP adjustment, is the benchmark. Scenarios two and three represent the provisions of the ACE and H.R. 1761 adjustments, respectively.

The model also assumes that tax-exempt interest income and the related interest-expense-disallowance provision are the only differences between book income and taxable income. Furthermore, tax-exempt interest is assumed to be the sole alternative minimum tax preference item. These simplifying assumptions appear reasonable given the tax characteristics of community banks.

Table 3. Representative Community Bank Balance Sheet, December 31, 1985

Item	Dollars	Percent of Total
Assets		
Cash and Due from Banks	9,017,714	6.5
Securities		
U.S. Treasury	23,377,925	16.8
U.S. Agency	6,623,357	4.8
Municipal	15,984,429	11.8
Total Securities	45,985,711	33.0
Loans		
Commercial Real Estate	7,228,500	5.2
Residential Real Estate	9,320,571	6.7
Farm Real Estate	4,828,857	3.5
Agricultural Production	16,319,571	11.7
Commercial	19,275,000	13.8
Consumer	10,885,071	7.8
Other	2,889,863	2.1
Total Loans	70,747,433	50.8
Loan Loss Reserve	(822,857)	−0.6
Net Loans	69,924,576	50.2
Federal Funds Sold	8,242,857	5.9
Property and Equipment	1,986,500	1.4
Other Assets	4,091,143	2.9
Total Assets	139,248,501	100.0
Liabilities		
Demand Deposits (noninterest)	18,257,357	13.1
Demand Deposits (interest)	13,890,714	10.0
Savings Deposits	25,801,000	18.5
Time Deposits	64,761,715	46.5
Total Deposits	122,710,786	88.1
Federal Funds and Repos Sold	1,144,071	0.8
Discount Window Borrowings	116,071	0.1
Other Liabilities	2,034,001	1.5
Long-term Debt	176,786	0.1
Total Liabilities	126,181,715	90.6
Equity		
Common Stock	2,065,286	1.5
Surplus	4,035,857	2.9
Retained Earnings	6,965,643	5.0
Total Equity	13,066,786	9.4
Total Liabilities and Equity	139,248,501	100.0

Source: Duncan (1989).

Results

The results of the three simulations are summarized in Table 4. As expected, a portfolio shift from tax-exempt to taxable securities will generate additional pretax

Table 4. Operating Results Under H.R. 1761 and ACE AMT Provisions Compared to Operating Results Under Present Law for a Typical Community Bank, 1990–93

Item	50% BURP	75% ACE	% Change from BURP	100% Proposed	% Change from BURP
Pretax Earnings					
Mean	$835,588	$851,184	1.9%	$861,204	3.1%
Standard deviation	$611,587	$669,926		$711,674	
After-tax Earnings					
Mean	$700,447	$682,451	−2.6%	$667,914	−4.6%
Standard deviation	$522,887	$550,674		$569,557	
Return on Assets					
Mean	0.47%	0.46%	−2.1%	0.45%	−4.2%
Standard deviation	0.35%	0.37%		0.39%	
Cumulative Income Taxes Paid					
Mean	$135,141	$168,733	24.9%	$193,290	43.0%
Standard deviation	$110,386	$131,703		$150,972	
Percentage of Assets Invested in Munies					
Mean	5.7%	4.9%	−14.6%	4.2%	−25.4%
Standard deviation	4.0%	3.4%		3.0%	
Value of Munies Owned					
Mean	$8,661,909	$7,385,424	−14.7%	$6,429,457	−25.8%
Standard deviation	$6,399,725	$5,464,847		$4,756,148	
Percentage of Investment Portfolio Comprised of Munies					
Mean	16.5%	14.1%	−14.5%	12.3%	−25.3%
Standard deviation	11.8%	10.1%		8.8%	

income for the bank. The pretax earnings increased by 1.9% and 3.1% from the base solution when considering the ACE and H.R. 1761 adjustments, respectively. Changing from BURP to ACE (occurring in 1990) results in an increase in taxes of 25%, while a 43% increase in taxes results under H.R. 1761. Yet, despite the substantial increase in income taxes, after-tax earnings show only a slight decline—3% and 5% under ACE and H.R. 1761, respectively. Here, almost the entire tax increase is mitigated by the marginal interest income yielded by the investment portfolio's partial shift from tax-exempt to taxable securities. This portfolio shifting occurs because ACE and H.R. 1761 both decrease the amount of municipal bonds banks find profitable to hold. Under the ACE and H.R. 1761 simulations, municipal-bond holdings declined 15% and 25%, respectively. Since the decline in both the percentage of assets invested in municipals and the percentage of the investment portfolio comprised of municipals is nearly equal, the banks replaced previously held municipal bonds with taxable bonds. The overall securities portfolio did not decline.

Summary and Conclusions

While the impact of the Tax Reform Act of 1986 and recent technical corrections on banks in general have been addressed elsewhere, the focus of this study was on community banks. These banks often face different community pressures than larger, metropolitan banks. Most community banks, compelled by community expectancy, are integrally involved in local-government capital-development projects. These projects are largely funded by municipal bonds with the expectation that the community bank will be a substantial purchaser of the obligations. Yet, federal tax policy, through the linkage of tax-exempt securities and the alternative minimum tax, creates a financial disincentive for community banks to maintain or increase their investment in local municipal bonds. If community banks choose to invest in taxable securities because they provide

greater after-tax returns than municipal bonds, local communities may find both increased funding costs and a potentially difficult market to finance their bonds.

The current replacement of the BURP adjustment is the ACE adjustment. Yet, Congress is still considering even tougher alternatives to the ACE adjustment. Such modifications could either follow the H.R. 1761 proposal or numerous other proposals. Nonetheless, the effect of both the ACE and H.R. 1761 adjustments was shown to be negative for community banks, in large measure due to a corresponding increase in taxes.

The financial disincentives for community banks to purchase municipal bonds will be further enhanced if a recent U.S. Supreme Court decision concerning tax-exempt income receives broad interpretation. In *South Carolina* v. *Baker* (April 20, 1988), it was held that the federal government can impose income taxes on state and local obligations. The Tax Equity and Fiscal Responsibility Act of 1982 opened the door by removing the federal income tax exemption for interest earned on publicly offered long-term bonds issued by state and local governments, unless those bonds are issued in registered form. While the law was an attempt to stem the flow of dollars into state and local bonds for tax-evasion purposes, the overall effect is to put aside a long-standing position of the immunity of interest on state and local obligations from the grasp of federal taxation. Of course, a partial or full taxation of municipal-bond interest for federal tax purposes would require raising the interest rate on the obligations. Such a condition would further exacerbate rural-community financing problems.

An increase in the cost of financing rural-government capital-investment projects will have a direct impact on the agricultural sector. Farmers and others involved in agribusiness rely on efficient transportation systems and other services provided by local governments. If the cost of borrowing for local communities increases, either the cost to taxpayers will increase or fewer dollars will be borrowed. In either case, future rural development may be impaired.

Additional research is needed to assess the impact of potentially increasing municipal-bond costs on rural community governments. The linkage between the federal tax law and community banks has been examined in this study. Future studies may model the rural community and address the financial relationships between community banks operating under alternative federal tax scenarios and the financing of community activities.

Another issue for future research could focus on community banks becoming part of a larger consolidated group of banks. Here, the possibility of a profitable community bank being combined with an unprofitable consolidated group would likely modify management's investment policy. Given the tax effects of a combined entity, there would likely be a decrease in the community banks' demand for municipal bonds.

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A Risk Endogenous Model of Aggregate Agricultural Debt

Charles B. Moss, J.S. Shonkwiler, and Stephen A. Ford

Abstract

Several factors interact to determine the optimal capital structure for a sole-proprietorship. The most important of these are the expected return on assets, the cost of additional capital, and the riskiness of the enterprise. This study uses an autoregressive conditional heteroskedastic (ARCH) model to estimate the effect of each of these factors on the level of debt in U.S. agriculture. The results indicate that debt increases as the expected returns increase and decreases as predicted variance increases.

Key words: aggregate debt, business risk, autoregressive conditional heteroskedastic.

The emergence of financial stress in agriculture in the 1980s focused increased attention on agricultural debt levels. During the 1980s, agriculture in the United States endured low cash returns coupled with generally declining asset values. As a result, debt obligations incurred during periods of relatively greater prosperity were now difficult to service. Thus, recent agricultural economics literature has begun to examine the policy implications of agricultural debt.

A primary focus of research into the policy implications of agricultural debt involves the idea of risk balancing. As introduced by Gabriel and Baker, "Risk balancing refers to the adjustment in the components of total risk (i.e., business and financial risk) that results from an exogenous shock to the existing balance." Business risk is the risk interest in the investor's assets. For example, business risk in agriculture may arise from price and yield variability. Financial risk results from the compounding business risk through leverage or liquidity decisions. Thus, under Gabriel and Baker's formulation, risk balancing involves a change in financial leverage or choice of liquidity resulting from a change in price or yield variability.

Gabriel and Baker's original model was developed using lexicographic preferences similar to Roy's safety first rule. However, several studies reformulated the model as a mean-variance portfolio choice model consistent with the expected utility hypothesis (Collins; Barry and Robison; Moss, Featherstone, and Baker). This study develops an empirical model to test the risk-balancing hypothesis over time. Specifically, an autoregressive conditional heteroskedastic (ARCH) model is used to estimate changes in aggregate agricultural debt resulting from changes in expected risk in agricultural returns.

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The policy ramifications of the results of this study could be significant. For example, Featherstone et al. developed a theoretical model, based on Collins, to examine the effect of eliminating government loan programs. Their results suggest that the elimination of price floors may induce a reduction in leverage sufficient to reduce the total risk facing a producer. One result of the ARCH formulation will be the responsiveness of agricultural debt to a change in projected risk. This result may be useful if policy makers are considering changes in government programs which affect the riskiness of the sector.

The next section of the study presents a theoretical model that relates financial risk to business risk via an optimal-leverage choice. Next, a time series model is used to project returns and risk through time. The projected returns and risk are then used to estimate a debt model. The study concludes with an evaluation of the empirical model and possible policy ramifications.

Modeling Capital Structure

Collins developed a simple model of investment consistent with the expected utility hypothesis based on the DuPont equation. The investor maximizes expected utility by choosing a leverage ratio, δ, (debt divided by assets),[1]

$$\max_{\delta} \bar{R}_E(\delta) - \frac{\rho}{2}\sigma_E^2(\delta), \tag{1}$$

where $\bar{R}_E(\delta)$ is the expected rate of return to equity, ρ is the Arrow-Pratt risk-aversion coefficient, and $\sigma_E^2(\delta)$ is the variance of the rate of return to equity. The rate of return to equity, $R_E(\delta)$, includes both income from the portfolio of operating returns, r_p, the rate of increase in asset values, i, the cost of debt, k, and the leverage ratio:

$$R_E(\delta) = [R_A - K\delta]\frac{1}{1-\delta},$$

$$\text{with } R_A = \frac{r_p}{A} + i, \tag{2}$$

where R_A is the total return to agricultural assets, and A is the value of assets. The variance of the rate of return to equity, $\sigma_E^2(\delta)$, likewise is a function of the variance of operating returns and the leverage ratio:

$$\sigma_E^2(\delta) = \frac{\sigma_A^2}{(1-\delta)^2}. \tag{3}$$

Collins, thus, derives the leverage that maximizes expected utility from equations (1), (2), and (3) to be

$$\delta^* = 1 - \frac{\rho\sigma_A^2}{[\bar{R}_A - K]}. \tag{4}$$

Differentiating equation (4) equals

$$d\delta^* = -\frac{\rho}{(\bar{R}_A - K)}d\sigma_A^2 + \frac{\rho\sigma_A^2}{(\bar{R}_A - K)^2}[d\bar{R}_A - dK]. \tag{5}$$

Hence, in Collins' model optimal leverage decreases with an increase in variance, increases with an increase in mean returns to assets, and declines with increases in the cost of capital.

For estimation purposes, equation (4) is multiplied by the level of assets (A), resulting in

$$D = A - \frac{A\rho\sigma_A^2}{[\bar{R}_A - K]}. \tag{6}$$

Since $A > 0$, this is a positive monotonic transformation which does not change the maximum or the signs of the derivatives:

$$dD = \left[1 - \left(\frac{\rho\sigma_A^2}{\bar{R}_A - K}\right)\right]dA + \left[-\frac{\rho}{(\bar{R}_A - K)}d\sigma_A^2 + \frac{\rho\sigma_A^2}{(\bar{R}_A - K)^2}d\bar{R}_A\right.$$

[1]This study uses the definition and terminology used in Collins. Thus, δ is defined as the debt-to-asset ratio, or leverage ratio. However, other writers have identified δ as the solvency ratio.

$$- \frac{\rho\sigma_A^2}{(R_A - K)^2}\, dK \Bigg] A. \qquad (7)$$

Thus, the theoretical model based on Collins' work indicates that debt is a decreasing function of the variance of the rate of return to assets, an increasing function of expected rate of return to assets, and a decreasing function of the cost of capital.

The preceding model was developed from postulates of firm-level behavior. Moving to aggregate data introduces several errors. First, optimizing behavior may not occur for every firm in the market. Second, the assumption of a negative exponential utility function is extremely restrictive. Further, even if all producers had negative exponential utility functions, there would be differences in their absolute risk-aversion coefficients. Finally, some capital markets may exhibit slow adjustment to changing financial conditions. Certainly capital-market imperfections can distract, at least temporarily, optimal financial allocations.

To mitigate these problems, this study uses a linear time series approximation to relate the variables of interest. This approximation will permit the same basic relationships derived earlier. Aggregate debt should increase with an increase in expected rate of return to assets and decline with an increase in the variability of rate of return to assets and the cost of capital. Specifically, the model used in this study is a linear time series of the form

$$D_t = f(A_t, R_{At}, \sigma_{At}^2, r_t). \qquad (8)$$

However, the level of debt (D_t) and the asset level (A_t) are simultaneously determined. From the individual firm's perspective, increased scale and its economies can only be accomplished through increased leverage (debt). In the past, agriculture has been unwilling or unable to raise capital from equity sources.[2] Hence, for a firm to increase assets with fixed equity, debt must be incurred. As a consequence, the firm's asset position is simultaneously determined by the level of debt.

In aggregate, changes in assets are less intuitive. A major portion of agricultural assets is real estate. Obviously, the amount of real estate in the United States is relatively fixed. Therefore, an increase in agricultural assets strictly due to real estate represents little additional investment in the aggregate.[3] However, intermediate assets, such as tractors, irrigation equipment, and other factors that increase the productivity of land, can be acquired. Also, the industry as a whole may increase inventories such as growing crops, cattle on feed, and stored grain. This increase in inventories would increase the sector's demand for operating or short-term capital. The simultaneity between debt level and asset values at the aggregate level is, thus, primarily attributable to increases in intermediate assets and inventories.[4]

Because first differencing yields a more stationary time series, the study uses a first-differenced linear approximation of equation (8) to determine the effect of interest rates, the expected rate of return on assets, and the expected variance on the change in aggregate debt. The estimated equation is

$$\Delta d_t = \alpha_0 + \alpha_1 \Delta d_{t-1} + \alpha_2 \Delta r_t + \alpha_3 R_t^*$$

[2]Certain exceptions to this statement do exist. For example, orange groves have been successful in raising capital through limited partnerships. Similarly, cattle-feeding operations and other very large or specialized production entities have been able to raise capital outside the sector. However, the majority of agricultural producers operate on retained earnings and debt capital. Other arrangements, such as crop share and cash renting, typically occur between retired farmers or heirs of farmers. Little interest has been shown in aggregate of nonfarm investors buying land to lease to agriculture in the long run. Further, machinery leasing is typically considered to be an installment sale under GAAP.

[3]Physically, there is little change in agricultural real estate each year. Some amount of real estate formerly in agriculture may be lost due to urbanization, and an increase in the rate of return to agriculture may slow this loss. However, the total amount of real estate is relatively fixed.

[4]The decoupling of asset values from real price changes may appear extreme. However, the basic tenet of the Collins model is that the firm expands to maximize utility. Possibly, the firm may expand to capture capital gains. However, to remain consistent with the scale arguments and avoid certain sector-level ambiguities, it is assumed that new capital expands production through additional equipment and inventory.

$$+ \alpha_4 V_t^*, \qquad (9)$$

where Δd_t is the first difference of the real debt level (D_t/i_t, where i_t is an inflation index), Δr_t is the change in the real cost of debt, R_t^* is the projected real rate of return on assets, and V_t^* is the projected variation in the real rate of return on assets. The change in asset values is not included in equation (9) because capital appreciation should be a linear function of income and the inverse of one plus the interest rate. Further, the study assumes that assets will only enter the sector through income and additional debt, or we assume that, in aggregate, production agriculture cannot raise capital through the sale of equity. The results from Collins' model (equation 7) suggest that α_2 should be negative, or that an increase in the real cost of capital should cause the level of debt to decline. Similarly, α_3 is expected to be positive since an increase in expected returns should lead to increased debt. Finally, V_t^* represents the investor's expectation about business risk. Therefore, α_4 is expected to be negative. The theoretical model developed earlier in the paper does not specifically sign α_1. However, if the aggregate time series data represent a partial adjustment process, then it is expected that $\alpha_1 > 0$.

Data

The model was estimated over the period 1950 to 1986. Data on aggregate debt, D, were derived from the USDA aggregate farm debt data. Aggregate debt, for the purpose of this study, is the total farm debt excluding farm households. This figure was deflated using the implicit GNP deflator from the U.S. Department of Commerce. First differencing the real level of debt yields the dependent variable in equation (9).

The interest rate for the farm sector was assumed to be the FICB interest rate from the U.S. Department of Commerce. A preferred discount rate may be the Production Credit Association (PCA) rate charged to farmers. However, the PCA rate could contain additional noise due to changes in lending practices. It is hoped that the use of the sector-level interest rate will reduce this noise. Finally, the rate of return on agricultural assets equals the total returns to agricultural assets before interest, excluding capital gains (Melichar).

Treatment of Expectations

In the theoretical model, the choice of debt was related to expected return on agricultural assets. Unfortunately, the expected return is not directly observable. Over a decade ago Feige and Pearce, and Pesando considered representing expectations in terms of univariate autoregressive models; that is, the information set used to generate expectations of a variable consists solely of the information on past values of the variable. A powerful rationale for this approach is the recognition that informational costs incurred in forming a completely rational expectation may be nontrivial for agents. Thus, assuming that agents understand the stochastic process generating the variable of interest, an autoregressive model can be used to model expectations.

In the present case not only is an expectation of real returns to agriculture, R_t, required, but its expected variance is as well. For the autoregressive model,

$$R_t = \beta(L)R_t + \xi_t. \qquad (10)$$

If the variance of the disturbance is $V(\xi_t) = \sigma^2$ for all t, then the conditional variance of R_t is σ^2. Thus, risk in the guise of variance is time invariant and collapses into the constant of the regression. In that case, the effect of risk on debt is not determinable. However, the data may show a more complex conditional variance function. Particularly, if Ω_{t-1} represents the information set known up through time $t-1$, and if $R_t|\Omega_{t-1} \sim N(\beta(L)R_{t-1}, h_t)$ such that $h_t = h(\xi_{t-1}, \xi_{t-2}, \ldots, \xi_{t-p})$, then in the terminology of Engle, we have autogressive conditional heteroskedasticity (ARCH) of order p. The ARCH regression model provides a mechanism by which the forecast variance may change over time by explicitly modeling variance as a function of past forecast errors. In this manner V_t^* can be constructed from h_t if the data suggest this type of heteroskedastic process.

The procedure for identifying the variance process begins by first specifying a

univariate autoregressive (AR) model for the R_t series. Using Box-Jenkins techniques, a third-order model was selected and is presented in Table 1. The model successfully whitened the residuals as indicated by a portmanteau statistic calculated from lagged residual autocorrelations. The value of the statistic was 8.48 and it is distributed as χ^2 with six degrees of freedom. Thus, the hypothesis of white noise cannot be rejected at any conventional level of significance.

The same test was then performed on the squared residuals in order to identify an underlying heteroskedastic process. This test yielded a value of 14.6, meaning that the hypothesis of a homoskedastic error process could be rejected at the .025 level. Examination of the partial autocorrelation function for the squared residuals suggested that the heteroskedastic process was third-order autoregressive. Therefore it was posited that $h_t = H(\xi_{t-1}, \xi_{t-2}, \xi_{t-3})$, and the method of maximum likelihood (Engle, p. 994) was used to reestimate the AR3 model taking into account the third-order ARCH process. Like Engle, we impose a two-parameter variance function of the explicit form $h_t = a_0 + a_1 (.3|\xi_{t-1}| + .2|\xi_{t-2}| + 1|\xi_{t-3}|)$. Absolute, rather than squared, residuals were used since the former guarantee finite variances and only require that $a_0, a_1 > 0$.

Estimation results for the ARCH model are presented in Table 2. Of particular interest is whether a_1 is significantly different from zero. If it is not, then no gain in efficiency is likely relative to the model in Table 1 and the conditional variance is constrained to be constant over the sample. In this case, producers may still respond to variance in choosing their debt level. However, since variance is constant through time, we can't empirically estimate the response. A likelihood ratio test of the hypothesis $a_1 = 0$ yields a test statistic of 11.45 which can be compared to a χ^2 with one degree of freedom. Thus, if producers choose debt in response to changes in variance, we should be able to estimate the effect of variance on leverage. Because the hypothesis is strongly rejected, the model in Table 2 can be used to generate both R_t^* and V_t^*.

Table 1. AR(3) Model for Real Returns

Variable	Coefficient	Standard Error
Constant	2.986	7.69
R_{t-1}	0.691	0.168
R_{t-2}	−0.123	0.205
R_{t-3}	0.226	0.188

Log of likelihood: −153.44.

Estimating the Debt Model

The empirical model of deflated aggregate U.S. farm debt as presented in equation (4) was first estimated using least squares regression. These results are shown in Table 3. Signs of the coefficients conform to a priori expectations, and the model shows a remarkably good fit considering the dependent variable is a first difference. Note that Durbin's *h*-statistic suggests some first-order negative autocorrelation in the residuals, although the hypothesis of no first-order autocorrelation cannot be rejected at the .10 level.

While the least squares results are useful for assessing coefficient magnitudes and model fit, the estimates of the parameters' standard errors are likely inconsistent due to the fact that two of the regressors are generated by another stochastic model (Pagan). This means that inferences as to significance may be misleading unless the estimation technique explicitly incorporates stochastic information regarding the generated regressors. This was accomplished following the approach recently suggested by Hoffman.

Table 4 displays the results of a generalized least squares regression for the same model which incorporates an adjustment for the two-step procedure. The standard errors and *t*-values are consistently estimated.

Table 2. AR(3) Model with ARCH Disturbances for Real Returns

Variable/ Parameter	Coefficient	Standard Error
Constant	7.568	7.07
R_{t-1}	0.744	0.198
R_{t-2}	−0.296	0.260
R_{t-3}	0.382	0.185
a_0	0.003	0.054
a_1	73.26	25.83

Log of likelihood: −147.71.

Table 3. Least Squares Estimates of the Change in Real Farm Debt

Variable	Coefficient	Standard Error	*T*-Value
Constant	0.003	0.086	0.035
Δd_{t-1}	0.665	0.108	6.16
Δr_t	−0.020	0.005	−3.98
R_t^*	1.152	0.189	6.10
V_t^*	−0.230	0.057	−4.03
R^2: .877			
h-statistic: −1.59			

Table 4. Generalized Least Squares Estimates of Real Farm Debt

Variable	Coefficient	Standard Error	*T*-Value
Constant	0.003	0.012	0.252
Δd_{t-1}	0.683	0.130	5.27
Δr_t	−0.020	0.005	−4.15
R_t^*	1.126	0.277	4.06
V_t^*	−0.2511	0.073	−3.46

Given that thirty-seven observations were used to estimate the debt model, we can see that all slope coefficients are significantly different from zero at the .01 level. The fact that the constant is not significantly different from zero means that there is no trend in deflated debt, d_t, since the model is estimated in first-difference form.

The results in Table 4 can be interpreted through two forms of implied elasticities. The most obvious way is to calculate the percentage change in the dependent variable, Δd_t, with respect to a change in the other economic variables evaluated at a point in time or at the means of the data. It is also possible to construct elasticities with respect to total deflated debt, d_t. Since the term of much agricultural debt exceeds the annual observation period, the latter set of elasticities would likely be much smaller. This relationship can be seen in Table 5

Table 5. Elasticities of Change in Debt and Debt Evaluated at Data Means

With respect to	Elasticity of Δd		Elasticity of d	
	Impact	Long-run	Impact	Long-run
Δr	−0.161	−0.508	−0.004	−0.011
R^*	1.342	4.235	0.030	0.095
V^*	−1.147	−3.617	−0.026	−0.081

where impact and long-run cumulative elasticities are presented for both series.

The findings in Table 5 show the strong influences expected returns and their expected riskiness have on the rate of change in debt. These findings can be contrasted to the impacts of these variables on total debt. To the extent that change in debt can be thought of as representing new investment (or disinvestment), the relationships in Table 5 provide remarkable evidence of how expected risk and return can affect the future course of U.S. agriculture.

Conclusions

The results of this study provide additional support for the risk-balancing hypothesis first advanced in Gabriel and Baker. Specifically, the results of this study indicate that a decrease in the variance or riskiness in aggregate agricultural returns will induce increased real debt in the farm sector. Further, the elasticity of real debt with respect to expected variance is greater than unity. This result suggests that the increased debt resulting from a decrease in the expected variance could actually increase the probability of financial stress in agriculture consistent with the results of Moss et al.

The policy implications of these results are that efforts to stabilize agricultural returns by stabilizing gross income may instead tend to destabilize agriculture because of debt decisions within the farm sector. Programs meant to stabilize farm income, such as target prices and loan rates, according to the results of the model, induce higher leverage. Further, the increase in leverage appears great enough to offset any gains from the stabilization policy, leaving agriculture more susceptible to future incidence of financial stress.

From a methodology perspective, the use of the ARCH model to represent both the mean and variance of expectations that are considered to be economically rational appears successful in generating proxies for these unobservables.

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Modeling Farm Financial Decisions in a Dynamic and Stochastic Environment

Allen M. Featherstone, Paul V. Preckel, and Timothy G. Baker

Abstract

Stochastic and dynamic linkages brought about by liquidity risk, collateral risk, and credit-reserve risk are important elements in capital-structure and investment decisions. Discrete stochastic programming (DSP) is one quantitative tool that can be used to capture the sequential and stochastic nature of farm capital-structure choices. Three steps in specifying a DSP are examined for a capital-structure application: (1) definition of the constraints, (2) definition of the probability model, and (3) specification of the objective function. The effect of the functional form of the utility function on the optimal solution is discussed.

Key words: discrete stochastic programming, liquidity, capital structure, utility functions.

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The farm financial crisis of the 1980s has underscored the need for understanding financial-structure decisions of the farm firm. The literature contains several attempts to model farm capital-structure decisions, but the modeling of liquidity remains a difficult problem. Discrete stochastic programming (DSP) is one methodology that can incorporate the stochastic and sequential nature of liquidity and optimal farm capital-structure decisions. The purpose of this paper is to describe the use of DSP for modeling investment and financing decisions. Specifically discussed are several aspects of DSP modeling, including the choice of an objective function, the description of random events, the incorporation of financial concepts such as liquidity and credit-reserve risk, and the interpretation of shadow prices. The intended audience for this article is primarily researchers modeling optimal capital structure. However, more precise investigation of farm capital-structure issues could be useful for producers, lenders, and policy analysts alike.

A farm operator attempts to achieve some goal or goals by simultaneously allocating scarce resources among various productive activities. Each year, decisions regarding production, investment, financing, consumption, and labor use must be made by the farm operator. These decisions are made with uncertain knowledge of the future, making the allocation process more difficult. Stochastic variables a farmer must consider when making decisions include farm prices, crop yields, interest rates, inflation rates, government agricultural policy, and production costs. In addition, most farmers plan for more than one year; thus, developing a viable long-term strategic

plan is of prime importance. Because of the stochastic and dynamic aspects of the farmer's decision problem, it is necessary to consider linkages between current and future decisions when determining the current year's strategy. In particular, treatment of liquidity requires modeling these stochastic and dynamic links.

Agricultural revenues are inherently risky; hence, there is a need for liquidity in the normal course of a farm's operation. As described by Barry and Baker, liquidity considerations arise through the combination of uncertain cash flows, changes in asset liquidity values and available credit, and the evolution of a firm's sources and uses of cash over time. A reduction in liquidity often occurs precisely at the time when the firm needs cash to meet its financial obligations. Liquidity risk also has a compounding effect. That is, if a sequence of years with poor returns occurs, the value of assets may be diminished. Hence, a greater portion of assets must be liquidated to meet financial obligations. This occurs because the agricultural asset market is a relatively thin market. When one farmer needs additional liquidity, other farmers in the same locale are also likely to need liquidity. Thus, productive assets may have to be sold at values far below "fair market value" in order to meet cash obligations. This reasoning does not follow when a series of good years occurs.

Credit-reserve risk is another important concept that needs to be taken into account when modeling optimal capital structure. Credit-availability risk has several dimensions. Collateral values are random variables. Thus, for those banks that lend based on collateral value, the amount which may be borrowed at any point in time will vary. Alternatively, some banks lend based on cash flows as well as collateral. The uncertain nature of agricultural income also makes cash flows uncertain, thereby making credit available risky. Barry, Baker, and Sanint present evidence that a farmer's credit limit is positively correlated with changes in farm income and asset values. Thus, in those years when extra liquidity is needed to meet cash obligations, the ability to obtain additional loans may be diminished. Finally, other variables that are independent of the farm, such as personnel changes, the lender's supply of funds, or changes in the policies of lending institutions, can cause the level of credit available to change.

The remainder of the article is organized as follows. First, previous research on capital structure is discussed. Second, the empirical farm optimal capital-structure model is discussed. Included in this section is a discussion of the constraints, a discussion of the stochastic model, a discussion of the objective function, and the interpretation of shadow values. Results and summary comments are then presented.

Previous Research on Capital Structure

The problem of modeling the farm capital-structure decision has confronted agricultural economists for many years. During the 1950s and 1960s, analyzing firm growth was a major research thrust for agricultural economists. Much of the firm modeling in this era used deterministic linear programming models or simulation models to obtain quantitative results (Irwin; Martin and Plaxico; Vandeputte and Baker; Halter and Dean). Optimal-control theory was also used to examine a firm's path through time (Dorfmann; Boussard; Larson, Stauber, and Burt). These models were limited by the computer technology of the time and ignored the stochastic nature of farm revenues.

The increased market risk of the 1970s shifted the research focus towards models which emphasized the management of risk. Portfolio theory developed by Markowitz was extensively utilized to derive risk-efficient sets of investments. Farm firms were modeled to evaluate the trade-offs between financial gain and risk. Quadratic programming and MOTAD have been used to analyze farm financial decisions (Barry and Willman; Sanint and Barry; Kaiser and Boehlje).

Simulation studies attempting to examine capital-structure changes in a full farm context have often included dynamic and stochastic elements (Ryan, Baum, Johnson, and Harrington; Richardson and Condra; Skees and Reid). However, simulation

models may not be well suited for determining optimal capital-structure changes induced by a new technology or institutional changes that change the underlying risks a firm faces. Simulation models use decision rules, frequently based upon historical observation, to make capital-structure decisions. With a change in technology or institutions, these decision rules are likely to change.

As an alternative to simulation, other research has studied financing decisions in conjunction with production decisions (Vickers; Lowenberg-DeBoer; Lowenberg-DeBoer and Boehlje). Vickers' model assumes the decision maker has an objective of maximizing the present value of the returns to equity. Applications of Vickers' model are usually solved using dynamic programming and reflect the decision maker's aversion to risk by adjusting the discount rate. In particular, the adjustment of the discount rate does not reflect risk-management strategies such as investment and financing decisions within a period. Hence, the level of debt chosen by the model is likely not optimal from an expected-utility perspective. Vickers' model can be adapted to incorporate liquidity risk and collateral risk into the analysis.

Modeling with Discrete Stochastic Programming

Discrete stochastic programming can be used to model the sequential, stochastic nature of farm decisions (Cocks; Rae 1971b; Klemme; Kaiser and Apland; Leatham and Baker). The formulation of a DSP can be divided into three steps: (1) definition of the constraints, (2) definition of the random events, and (3) specification of the decision maker's objective function.[1] The remainder of the paper will examine each of these steps in the context of building a farm model to examine optimal capital structure.

Definition of the Constraints and Variables

One of the important steps in formulating a DSP is the definition of the constraints. If the number of time periods is k and the number of probability states is s, then s^k decision nodes are in the model. If the number of decision variables at each stage and state is n and the number of constraints is m, then the problem will contain ns^k variables and ms^k constraints. The rapid growth in model size is called the "curse of dimensionality." Due to inevitable limits on model size, it is important to remember that addition of constraints (m) will reduce the richness of the probability set (s) and/or the number of decision points (k) that can be modeled. On the other hand, eliminating constraints (variables) needed to obtain "real world" conditions will limit the conclusions drawn from a DSP.

The optimal capital structure model presented in this paper has thirteen types of constraints. (A complete mathematical formulation can be found in the appendix). Two types of land constraints are used. The first set of land constraints limits land sold or farmed to be less than or equal to land owned. The second type of land constraints transfers owned land from one period to the next. Three types of machinery constraints are used. The first set of constraints ensures that more machinery is owned than is necessary to farm owned and rented land. The second set of constraints transfers machinery from one period to the next, whereas the third set of constraints calculates the amount of machinery to be purchased. Two types of hog-facility constraints are used. The first set calculates the amount of hog facilities needed, while the second set transfers facilities from one period to the next.

Two types of labor constraints are used. The first constrains labor use during the summer, while the second constrains labor use during the fall and spring. The fall and spring periods are combined into one set of constraints; thus, fall and spring labor requirements are modeled as proportional. Adding an additional labor period would add 279 constraints in the final model.

Three types of financial constraints are used. The first set of constraints limits borrowing. The second set of constraints ensures that total assets equal debt plus owner's equity. The third set of constraints calculates the change in owner's equity,

[1] An intuitive description of DSP can be found in Featherstone, Baker, and Preckel for those not familiar with this methodology.

adds it to beginning-of-period equity, and transfers equity to the next period. Because there are no additions or withdrawals to equity other than consumption, the second and third sets of constraints also force sources and uses of funds to be equal in all periods in all states of nature.

The final set of constraints includes fixed bounds for the initial period and other types of bounds. The other types of bounds included limit hired labor, off-farm employment, and crop acreage. These can be used to obtain compliance with government-program restrictions (e.g., a wheat base). The use of bounds on individual variables instead of constraints reduces the computational effort for most mathematical programming systems, including MINOS.

Other types of assumptions were made to reduce the number of variables and the size of the constraint set. Consumption was modeled as a fixed amount in each period and was deducted from the right-hand side of the equity constraint in each state of nature and each year. Evidence suggests that the marginal propensity to consume for farm families is between 3% and 5% in the short run (Langemeier and Patrick; Carriker, Featherstone, and Schroeder). Thus, changes in income were assumed not to affect the level of consumption.

Variables were included to reflect production choices as well as investment and disinvestment in the optimal capital structure model. Production variables include raising wheat on owned land, raising corn and soybeans in a 50–50 rotation on owned land, share-rented land or cash-rented land, and raising hogs. Assets owned include land, machinery, and hog-confinement buildings. Land can be bought and sold, machinery can be purchased, hog facilities can be purchased, and money can be invested off the farm each year. Labor can be hired in both the fall and summer, or the farmer can work off the farm. Other variables include debt and owner's equity.

Modeling Asymmetry in Constraints

One important type of asymmetry for determining optimal capital structure is liquidity. DSP is ideally suited to model liquidity because the uses of cash can be constrained to equal sources of cash in all states of all periods, even when cash returns, cash expenses, liquidity values of assets, and credit available are random variables. At a given decision node, a DSP model can capture the benefits of acquiring liquidity reserves such as liquid assets or holding credit reserves. These benefits include avoiding the sale of an illiquid asset, such as farmland, in some state or states at a later stage.

The value of holding liquidity reserves is highest when a portfolio has a high percentage of assets with liquidity risk. An asset with liquidity risk is one whose conditional price distribution has a lower mean in states with reduced cash flow. Such might be the case with farmland and machinery whose values will tend to be lower when farm product prices and the associated cash flow are low. Land values were determined based on the current level of cash flow and the two previous periods' land prices (Featherstone and Baker). Thus, the liquidity value of land is directly affected by cash flow. Liquidity risk is modeled by increasing the transactions cost of liquidating land when land value has decreased from the previous year.

Credit reserves may not prove to be adequate sources of liquidity because of the relationship between uncertain collateral values and available credit. Modeling credit uncertainty is also possible using DSP. This is accomplished by making the credit limit a function of current equity.[2] Modeling credit reserve in this manner makes credit availability a function of the collateral value. The example above makes the credit reserve risky since available credit falls when asset values, and therefore equity, fall.

Definition of the Random Events

In some cases, DSP models have had the same number of states for every year modeled (Leatham and Baker; Rae; Klemme). The discrete states of nature collectively define the universe of outcomes

[2]One reviewer pointed out that a random component could be added to this relationship to model other considerations that affect lender behavior.

assumed to be perceived by the decision maker. Each individual state represents an outcome and is weighted by the decision maker's subjective probability of that individual event occurring. The discrete states of nature can be viewed as an approximation to the continuous distributions that capture the nonstochastic and stochastic relationships among the random variables.

One approach to manageable model formulation is to have a greater number of states of nature in the initial periods than the later periods.[3] Decision makers are more likely to be able to specify more completely the ranges of outcomes and the subjective probability of those outcomes occurring during the initial stages than they are during stages in the distant future.

Random-variable outcomes for each state of nature and the probability of each state must be defined for each stage. Implicitly, these stages and probabilities define the stochastic process underlying the random variables. The probabilities may be estimated directly based on a discrete state space. Alternatively, a stochastic process with continuous state space may be estimated. The continuous state space must then be made discrete for use in the DSP model.

In a farm planning context, random variables (e.g., prices, yields, and interest rates) are sometimes obtained as continuous variables. Before addressing the issue of obtaining discrete distributions from continuous ones, it is worthwhile to consider the appropriate selection of random variables.

Frequently, there will be several random factors associated with a given stage. In some cases, these may be combined. For example, for a given season, both corn yields and prices may be random variables. If the revenue from an acre of corn is the quantity of interest, then it is worthwhile to focus on the distribution of the product for yield and price. This approach of reducing the number of random variables will help limit problem size while maintaining the degree of accuracy in representing the continuous distribution in discrete state space.

Another approach to reducing the number of random variables is to treat some random variables as deterministic functions of other random variables. For instance, if both the off-farm savings rate and the interest rate on farm loans are very highly correlated, then the interest rate for farm loans might be set equal to the savings rate plus a fixed number of points.

Once the essential random variables have been identified, the states can be selected. Conceptually, the discrete states of nature represent the universe of outcomes. Therefore, any discrete approximation of a distribution needs to capture the stochastic and nonstochastic relationships among the random variables, including asymmetric relationships.

Several methods may be used to approximate the distribution. One method would be to randomly draw the desired number of states from the joint probability distribution and use those random values as the discrete states and an equally likely probability for each discrete state. This causes a problem when the number of states is small, as will usually be the case.[4]

A second method for approximating the continuous joint distribution would be to partition the probability space into regions, calculate the probability of each region, and then select a point in each region to be used as the discrete state of nature. The advantage of this is it partitions the region to get a more stratified sampling between groups. However, a case could exist where two points right next to each other, although in different regions, were selected. Essentially the same information would be

[3]This approach is described in Anderson, Dillon, and Hardaker. One of the reviewers also suggested that less detail may be included in later stages through the definition of activities and constraints as well as the number of states of nature.

[4]If discrete data points are available, it is also worthwhile to consider selection if all outcomes will not be used or if they will be weighted unequally. Also, if more observations are available than can be modeled, the discrete observations will need to be reduced. Using actual data points will avoid the problem of underestimating higher moments.

contained in the two points and model size would be larger than necessary.

The method used in this article is to partition the joint probability distribution into the selected number of regions, calculate the probability of each region using numerical integration, and calculate the conditional mean of each variable in the region and use the conditional means as the outcome. This approach guarantees preservation of the mean of the distribution, unlike the methods which require sampling, however it has been shown that variance is underestimated (Miller and Rice). The use of Gaussian quadrature to identify the states of nature is shown to be the preferred alternative.

In this application, three random variables are of interest, and using nine states for the first period was deemed practical. The trivariate space was partitioned into nine states by having one region be the volume within plus or minus one standard deviation of each of the means. The remaining probability space partitioned along the x, y, and z axes formed the other eight regions. The probability and the conditional mean of each region can be calculated either analytically or by using numerical integration. The conditional means are used as the discrete realizations for the states of nature, and the probability of an occurrence in a region is assigned as the probability of the state of nature.

If several variables are combined into one variable (e.g., wheat revenue from the illustration above), the computation of the conditional mean and probability involves multiple integration. (For this study, these integrals were computed using the subroutine of Kaylen and Preckel.) In the example of wheat revenue, the discrete approximation to the distribution of the product of wheat yield and wheat price must be obtained from the joint-density function for yield and price. This is achieved as follows. To get the probability that wheat revenue falls in a specified range, integrate the joint-density function over the region where the product of price times yield falls in the specified range. To get the conditional mean for the region, integrate price times yield times the joint density again over the region where revenue falls in the specified range.

Definition of the Objective Function

Various approaches exist for specifying an objective function for a multiperiod, finite-horizon model. Some are based on period-by-period consumption, while others focus on terminal wealth. Theoretical economic models often assume that utility is derived from each period's consumption and from a bequest motive. Following this approach would require construction of an empirical function which is often assumed to be additive and separable across time (Deaton and Muellbauer). The additive components are weighted by a constant representing the consumption time preference of the decision maker.

The approach of using an additive and separable utility function versus the utility of only terminal wealth has the advantage of making the trade-off between consumption and retained earnings endogenous. However, the choice of the rate of time preference in trading off consumption for terminal wealth is critical in models where the modeled time horizon is less than the actual time horizon. If the internal rate of return on investment is greater than the time preference for consumption, the decision maker will limit consumption in the early periods to obtain a larger terminal wealth. If the internal rate of return is less than the rate of time preference for consumption, the decision maker will consume wealth and leave little for future consumption. Thus, in practice, relative amounts of consumption and retained earnings for each period are somewhat determined by the exogenously specified time preference. This phenomenon would be offset to some extent by the use of utility functions in each period.

In the context of models incorporating elements of risk, Reid and Musser suggest that maximizing the expected utility of terminal wealth may be the most practical approach. The remainder of this article focuses on the objective of maximizing the expected utility of terminal wealth.

Rae (1971a) discusses the choices that exist for a utility function in a DSP including

single-attribute, multiattribute, or lexicographic utility functions. He mentions using the mean-variance (EV) objective function, mean less a multiple of the sum of absolute deviations objective function (MOTAD), and Taylor series approximations of other utility functions. Theoretically, any of these types of objective functions can be used in modeling. However, alternative functions result in different decisions and problem formulations that are more or less difficult to solve. No empirical considerations of the use of alternative utility functions are provided in Rae's paper.

The remainder of this section discusses the operational strengths and weaknesses of three commonly used (single-attribute) utility functions. The objective functions discussed include the mean-variance expected-utility approximation and two direct expected-utility objectives: the negative exponential and the power function.

The EV function. The use of the EV objective function can be justified by assuming a quadratic utility function or assuming normally distributed returns. Another common interpretation of the EV objective function assumes the individual's utility function is negative exponential and the returns are normally distributed (Freund). In this case, the EV objective function gives results that are identical to expected utility, and the trade-off between mean and variance is one-half the measure of absolute risk aversion. A third justification for the use of an EV objective function is sufficient approximation. That is, an expected utility maximizer will lose little, if any, expected utility by choosing from the EV set. This has been empirically shown in the work of Levy and Markowitz, and Kroll, Levy, and Markowitz.

One commonly used expected-utility approximation in empirical research is the EV objective function. The EV objective function in a DSP can be expressed as follows:

$$Z = \sum_{t=1}^{T} p_t W_t - \theta/2 \left(\sum_{t=1}^{T} p_t (W_t)^2 - \left(\sum_{t=1}^{T} p_t W_t \right)^2 \right), \tag{1}$$

where Z is the objective value, W_t is wealth for terminal node t, p_t is the marginal probability of ending in occurrence for terminal node t, and θ is a parameter that describes the decision maker's trade-off between mean and variance. The use of the linear formulation of the EV objective function can be justified using the Freund or the sufficient-approximation justifications.

Negative-exponential utility function. The expected value of the negative-exponential utility function is

$$E[U(W)] = \sum_{t=1}^{T} p_t (1 - e^{-\lambda W_t}), \tag{2}$$

where λ is the constant Pratt-Arrow coefficient of absolute risk aversion, and p_t and W_t are defined as before. Nonlinear programming can be used to solve a DSP with a negative-exponential utility objective function.

Power utility function. The power function is less well known than either the EV or the negative-exponential objective functions, but it has several noteworthy properties. The power function is consistent with multiperiod expected utility when returns are independent over time (Gauer). Hakansson has shown that the maximization of the utility of terminal wealth implies maximization of utility functions of intermediate wealth with n periods to go. The expected value of the power utility function is

$$E[U(W)] = \sum_{t=1}^{T} p_t \left(\frac{W_t^{1-\rho}}{1-\rho} \right), \tag{3}$$

where $\rho \geq 0$ is the Pratt-Arrow coefficient of relative risk aversion (which is constant). Use of the power function implies decreasing absolute risk aversion. The power function, unlike the EV and the negative-exponential utility functions, is not well defined in those states of nature where

ending owner's equity is negative. This may or may not be a problem depending upon whether or not terminal wealth may be negative. It may be desirable to use the power function to value the utility of wealth in states of nature with positive wealth while using a different functional form to value the utility of wealth when wealth is very near zero or negative. There are two reasons one might find this desirable. First, one may wish to use the power function because decreasing absolute risk aversion is desired. However, the function's behavior at infinitesimal and negative wealth may be judged to be incorrect for the decision maker being modeled.[5] Second, the solution algorithm may fail if negative wealth in some states occurs at intermediate nonoptimal solutions.

The problem of negative wealth can be accommodated by using a Taylor's series approximation of the power function over the region where wealth attains small and negative levels. Define a modified power function as

$$\tilde{U}(W) = \begin{cases} \dfrac{W^{1-\rho}}{1-\rho}, & \text{if } W \geq \epsilon; \\ \dfrac{\epsilon^{1-\rho}}{1-\rho} + \epsilon - \rho(W-\epsilon) & \\ \quad - \dfrac{\rho\epsilon^{-\rho-1}}{2}(W-\epsilon)^2, & \text{if } W < \epsilon. \end{cases} \tag{4}$$

The constant ϵ is positive but small; thus, $\tilde{U}$ is well defined for all values of W. If ϵ is chosen to be sufficiently small, then near-zero and negative levels of wealth will be severely penalized. From the point of view of solving the problem, it is noteworthy that the modified power function is twice continuously differentiable as is theoretically required by solution packages based on Newton-type methods (e.g., MINOS; Murtagh and Saunders).

[5]Although negative terminal wealth is unlikely to be valued any differently than zero terminal wealth by many individuals, the discussion included negative terminal wealth for those cases where an income variable is used instead of a wealth variable as the argument in the utility function.

Interpretation of the Shadow Prices

Often the dual solutions contain as much or more economic information as the primal solution. However, the units associated with the dual solution are difficult to directly interpret. Preckel, Featherstone, and Baker demonstrate the conversion of shadow prices expressed in units of marginal expected utility into units which are more readily interpretable. With the choice of any of the utility functions discussed in the previous section, the shadow price on a constraint will be in units of marginal expected utility per additional unit of resource. This section illustrates how shadow prices expressed as expected-utility units can be converted to certainty equivalents, making interpretations more meaningful.

The Preckel, Featherstone, and Baker results can be extended using the following equation:

$$\frac{\partial CE}{\partial X} = \frac{\partial E(U)}{\partial X} \div \frac{\partial E(U)}{\partial CE}, \tag{5}$$

where $\partial CE/\partial X$ is the marginal amount of certain wealth that the decision maker would pay for an additional unit of X, $\partial E(U)/\partial X$ is the marginal expected utility obtained from an additional unit of X, and $\partial E(U)/\partial CE$ is the marginal expected utility obtained from an additional unit of certain wealth.[6]

For the EV objective function, the objective value is equal to the certainty equivalent. The certainty equivalent is the least amount of certain wealth that the decision maker would trade for the risky outcome. The level of expected utility of the gamble is equal to the utility of the certain outcome. By definition, a certain outcome has zero variance. Interpretation of shadow price in units of the certainty equivalent is straightforward since $\partial E(U)/\partial CE = 1$.

Calculation of the certainty equivalent for

[6]In most cases, the utility function will not be a direct function of the quantity of interest, X. In particular, if X is a constraining resource for period i state j, then the shadow price on the constraint should be substituted for the derivative of $E(U)$ with respect to X in (5).

the negative-exponential and the power utility functions is also straightforward as is the calculation of the marginal expected utility per additional unit of certain wealth. For the negative-exponential utility function:

$$\frac{\partial E(U)}{\partial CE} = \sum_{t=1}^{T} p_t \lambda e^{-\lambda W_t}. \tag{6}$$

The marginal expected utility per additional unit of the certainty equivalent is the expected value of marginal utility. For the power utility function, the marginal expected utility for an extra unit of certainty equivalent is

$$\frac{\partial E(U)}{\partial CE} = \sum_{t=1}^{T} p_t W_t^{-\rho}. \tag{7}$$

The ability to convert the shadow prices into units of certainty equivalents per unit of a particular resource greatly enhances the interpretation of discrete stochastic programming results. Using the Preckel, Featherstone, and Baker results in conjunction with the definition of marginal expected utility per marginal unit of certainty equivalent defined above, one can convert shadow price expressed in units of marginal expected utility per additional unit of resource into units of marginal certainty equivalent per unit of resource. Because of the information provided by meaningful shadow prices and the theoretical foundations, the EV, the negative-exponential, and power utility functions are all possible candidates for use in a DSP.

Empirical Considerations

So far, mainly theoretical issues have been discussed with regard to the objective functions and DSP. When choosing between either the EV, the negative-exponential, or the power utility functions, it is important to consider the effect of the choice on model behavior and difficulty of solution. For example, do all three formulations give similar results when the Pratt-Arrow absolute risk-aversion coefficient is the same? If the results are similar, is one function computationally superior?

The DSP model of the crop-hog farm described earlier is used to answer these questions.[7] The farm model is a four-year DSP model with 900 terminal nodes. The model has 4,262 constraints, 6,225 activities, and 900 nonlinear variables. The farm is assumed to be operating with an initial debt-to-asset position of 40%. Other assumptions with regard to the specifics of the policy environment and the constraint-matrix formulation can be found in Featherstone.

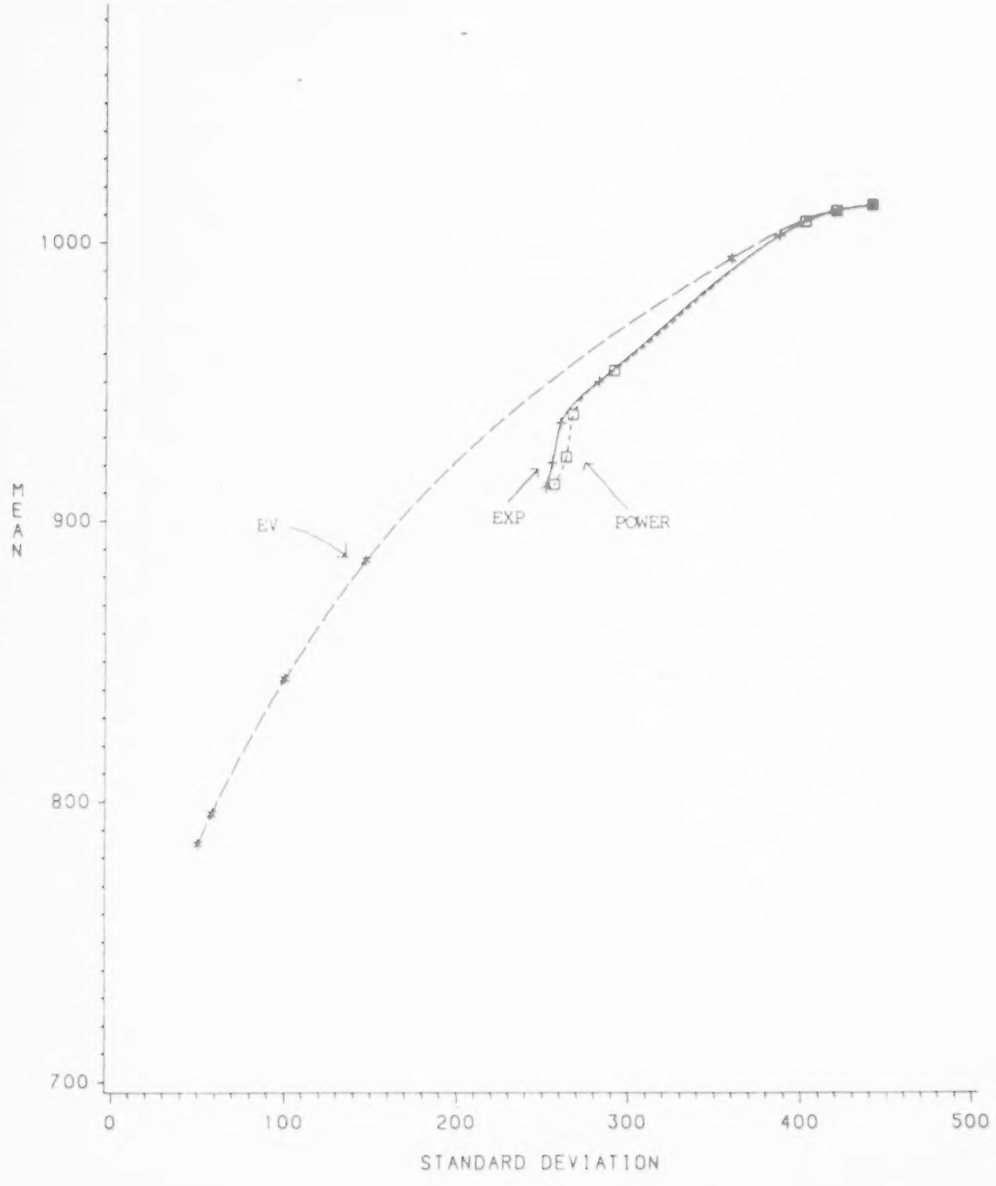
Figure 1 is a graph of mean ending wealth and standard deviation of ending wealth for the three objective functions. (This graph was generated by solving the model repeatedly for a range of risk-aversion coefficients.) The mean and standard deviation of wealth are nearly identical for the power and the negative-exponential utility functions for all relevant levels of risk aversion. The EV function, however, differs significantly. At higher levels of risk aversion (lower levels of the mean), the EV objective function has a smaller mean ending wealth and a smaller mean standard deviation of ending wealth. Detailed examination of the solutions reveals that the farmer with the EV objective function begins to act in a seemingly irrational manner as the farmer becomes more risk averse. To reduce the variance of ending net worth, the farmer reduces equity during the last year in those states that have been most profitable by simultaneously buying and selling land at a loss equal to the transaction costs. This action substantially reduces the variance with only a modest reduction in the mean. This phenomenon does not occur with the negative-exponential or power utility functions.

Table 1 shows the certainty-equivalent value of ending wealth under the alternative utility assumptions for various Pratt-Arrow risk-aversion levels.[8] As would be expected, a risk-averse individual has a lower

[7]Due to the large number of stock variables (owner's equity level, land and capital inventories, etc.) and the number of inequality constraints on decisions (credit availability, machinery capacity, etc.), a DP recursion formula for this formulation of the problem would have an impractically large state space. However, in theory, a DSP problem could be reformulated for solution via DP techniques and vice versa.

[8]The risk-aversion level (ρ) was determined by multiplying the Pratt-Arrow risk-aversion coefficient by beginning wealth.

Figure 1. Mean Ending Wealth and Standard Deviation of Ending Wealth of the EV, Negative-Exponential, and Power Utility Functions



certainty-equivalent value for farming than does the more risk-neutral individual. At levels of risk aversion less than .00001, the power function has the largest certainty equivalent followed by the negative-exponential and then the EV objective functions. At the levels of risk aversion examined that were greater than .00001, the ordering reverses. Although the mean and standard deviation of ending equity are significantly different at high levels of risk aversion with the EV function, the certainty equivalents are not substantially different. The EV function obtains a higher certainty equivalent, and thus expected utility, by acting in an irrational manner. This

Table 1. Certainty Equivalents for Various Pratt-Arrow Absolute Risk-Aversion Levels under the EV, Negative-Exponential, and Power Utility Functions

Absolute Risk Aversion	Utility Functions		
	EV	EXP	POWER
	$ Thousands		
5×10^{-8}	1008	1008	1010
1×10^{-7}	1003	1004	1006
5×10^{-7}	967	971	982
1×10^{-6}	929	939	955
5×10^{-6}	832	842	852
1×10^{-5}	794	798	803
2.333×10^{-5}	757	745	743
3×10^{-5}	748	730	727

suggests that the EV utility function may not be appropriate for DSP models.

Although the EV function behaves inappropriately at higher risk-aversion levels, the suggested early optimal decisions may not be substantially different, thus making the inappropriate behavior irrelevant in the modeling process. Table 2 illustrates the similarities and differences in the optimal decisions under alternative utility assumptions. The more risk-averse farmer raises more hogs in proportion to crops and owns less land. The largest difference in the optimal levels of activities under the alternative utility functions is in the amount of hogs raised. Farmers with an EV objective function raise at least as many hogs at every level of risk aversion than do farmers with negative-exponential or power utility functions. At higher levels of risk aversion, the farmer with an EV objective function has more farm assets than the farmer with a negative-exponential or power utility function.

Table 3 shows the shadow prices for an extra unit of resource under various

Table 2. Optimal Levels of Selected Activities for Various Pratt-Arrow Risk-Aversion Levels under the EV, Negative-Exponential, and Power Utility Functions

	Owned Land			Year 1, Off-Farm			Hogs	
θ[a]	Year 1	Year 2[b]	Year 3[c]	Debt	Investment	Rotation	Year 1	Year 2[b]
	Acres			*$ Thousand*			*Sow Units[d]*	
EV								
5×10^{-8}	800	800	800	524	9	638	51	45
1×10^{-7}	800	800	800	524	9	638	51	45
5×10^{-7}	696	696	696	497	92	565	51	58
1×10^{-6}	515	515	515	433	217	439	51	111
5×10^{-6}	20	20	92	0	183	29[e]	84	141
1×10^{-5}	0	0	25	0	264	66[e]	67	139
2.333×10^{-5}	0	0	0	0	322	101[e]	51	104
3×10^{-5}	0	0	0	0	322	101[e]	51	99
EXP								
5×10^{-8}	800	800	800	524	9	638	51	45
1×10^{-7}	800	800	800	524	9	638	51	45
5×10^{-7}	696	696	696	476	71	565	51	50
1×10^{-6}	527	527	527	386	158	447	51	86
5×10^{-6}	48	48	65	0	248	86[e]	58	133
1×10^{-5}	0	0	0	0	322	101[e]	51	107
2.333×10^{-5}	0	0	0	0	322	101[e]	51	51
3×10^{-5}	0	0	0	0	322	101[e]	51	45
POWER								
5×10^{-8}	800	800	800	524	9	638	51	45
1×10^{-7}	800	800	800	524	9	638	51	45
5×10^{-7}	696	696	696	436	31	565	51	45
1×10^{-6}	606	606	606	393	83	502	51	62
5×10^{-6}	74	74	74	0	247	101[e]	51	125
1×10^{-5}	0	0	0	0	322	101[e]	51	102
2.333×10^{-5}	0	0	0	0	322	101[e]	51	47
3×10^{-5}	0	0	0	0	322	101[e]	51	45

[a]θ is the Pratt-Arrow risk-aversion coefficient.

[b]The second-year decisions listed have a 1-in-3 chance of occurring and are from the most-likely second-year state of nature.

[c]The third-year decisions listed have a 1-in-6 chance of occurring and are from the most-likely third-year state of nature.

[d]A sow "unit" farrows seven times a year and yields 41,400 pounds of market hogs per year.

[e]Acres of corn-soybean rotation grown on share-rented land.

utility-function assumptions. The shadow prices do not vary much under the alternative utility function assumptions. The only major difference occurs on the hog-facilities constraint under the EV utility function. At those risk-aversion levels where the farmer raises additional hogs during the first year, the shadow price on additional facilities is higher.

The empirical model was solved using MINOS 5.0 on an IBM 3083 mainframe computer. Model solution required 8 megabytes of memory. The choice of utility function had a significant effect on the amount of time required to solve the model. For example, the CPU time required to move from the expected wealth maximizing solution (LP) to the Pratt-Arrow absolute risk-aversion level of 5×10^{-6} was 24 minutes and 5 seconds using the EV objective function. Using the negative-exponential utility function required 11 minutes and 2 seconds to solve using the same Pratt-Arrow risk-aversion level (starting from the LP solution). The power function required 11 minutes and 11 seconds. It should be noted that the time required to obtain the expected wealth maximizing solution is not trivial (roughly 2 hours of CPU time).[9]

This section has considered the use of three alternative objectives—EV, negative-exponential, and power utility—for discrete stochastic programming. For our example, the negative-exponential function and the power function are preferred over the EV objective function for two reasons. First, a model with an EV objective function exhibited seemingly irrational behavior in the final DSP stage. In the context of some problems, decisions made in the final stage are an integral part of the problem, rendering the EV objective function unattractive. Second, for our example, the

[9]The cost of a CPU hour at Purdue University was $500 during 1988.

Table 3. The Marginal Contribution of Resources to Certainty Equivalents for Various Pratt-Arrow Risk-Aversion Levels under the EV, Negative-Exponential, and Power Utility Functions

θ^a	Initial Land	Initial Equity	Economic Rent	Cash Rent	Share Rent	Hog Facilities
	$/Acre	$/$	*$/Acre*	*$/Acre*	*$/Acre*	*$/$ Invested*
EV						
5×10^{-8}	−20.10	1.413	40.26	−50.78	−12.83	.187
1×10^{-7}	−25.66	1.406	39.21	−51.42	−13.08	.186
5×10^{-7}	−59.22	1.356	31.46	−55.93	−14.82	.185
1×10^{-6}	−83.10	1.312	26.37	−58.19	−14.54	.186
5×10^{-6}	−107.26	1.238	40.43	−47.05	0	.197
1×10^{-5}	−113.33	1.198	37.59	−48.35	0	.188
2.333×10^{-5}	−115.68	1.169	35.73	−48.99	0	.178
3×10^{-5}	−116.83	1.162	35.38	−49.05	0	.173
EXP						
5×10^{-8}	−20.06	1.413	40.28	−50.77	−12.83	.187
1×10^{-7}	−25.51	1.407	39.26	−51.39	−13.07	.187
5×10^{-7}	−55.30	1.366	32.68	−55.33	−14.58	.185
1×10^{-6}	−78.37	1.334	27.21	−58.76	−15.89	.182
5×10^{-6}	−105.39	1.241	40.81	−46.88	0	.170
1×10^{-5}	−112.32	1.187	37.66	−48.11	0	.184
2.333×10^{-5}	−115.21	1.129	36.43	−48.92	0	.155
3×10^{-5}	−115.25	1.115	37.14	−49.21	0	.145
POWER						
5×10^{-8}	−18.73	1.420	40.75	−50.75	−12.80	.187
1×10^{-7}	−22.94	1.420	40.18	−51.36	−13.01	.187
5×10^{-7}	−46.25	1.421	36.15	−55.44	−14.43	.187
1×10^{-6}	−71.78	1.423	31.75	−59.93	−15.99	.186
5×10^{-6}	−108.83	1.349	44.89	−50.03	0	.183
1×10^{-5}	−121.08	1.296	41.52	−52.05	0	.182
2.333×10^{-5}	−125.51	1.228	40.22	−53.46	0	.177
3×10^{-5}	−125.17	1.208	41.07	−53.68	0	.181

[a]θ is the Pratt-Arrow risk-aversion coefficient.

EV objective function was computationally more expensive than either of the other utility functions. The computational costs of the power and negative-exponential utility functions were about the same for our example. The relevant consideration in choosing between the power function and the negative-exponential utility function is whether constant absolute, or constant relative risk aversion is more appropriate for modeling decision-maker preferences.

Summary Comments

Stochastic and dynamic linkages brought about by liquidity risk, collateral risk, and credit-reserve risk are important elements in capital-structure and investment decisions. Theoretical models of capital-structure choice have been developed, but few empirical applications of these models have been reported. Discrete stochastic programming (DSP) is one quantitative tool that may be used to model the stochastic and dynamic linkages important in capital-structure decisions. Widespread application of DSP has probably not occurred because of the need for detailed specification of resources and resource requirements, and the "curse of dimensionality." In this article, the specification of a DSP was discussed in three steps: (1) definition of the constraints, (2) definition of the random events, and (3) specification of the objective function. Each of these steps was discussed in the context of a farmer's optimal capital structure and investment decisions.

Suggestions on how to include asymmetries of liquidity risk and collateral risk in a DSP model were discussed. Methods for approximating discrete joint probability distributions from continuous joint distributions while capturing the stochastic and nonstochastic relationships among the random variables were discussed. The alternative empirical strengths and weaknesses of three objective functions—mean-variance, negative exponential, and power or isoelastic—were examined. Finally, it was shown how shadow prices could be converted into readily interpretable units instead of units of marginal expected utility. The results indicate that direct utility maximization may be preferred to mean-variance approximations in DSP modeling.

Although relatively few applications of DSP exist, DSP can be used to solve a wide variety of problems. This paper has discussed steps required in constructing a DSP. Results indicate that DSP can be used to model complicated real-world decisions. DSP is a tool that can be used to offer insight and recommendations with regard to capital-structure choices.

Appendix: Formulation of the Discrete Stochastic Programming Model

Notation

In order to present the mathematical model, notation is defined in this section. Variables will be in upper case and parameters will be in lower case.

Subscripts

Subscripts indicate the year, the current state, and the previous state. Let

- t denote the year in which a decision is made ($t = 1, \ldots, T$), where T is the end of the planning horizon;
- i , denote the number of the state at time $t + 1$ ($i = 1, \ldots, I_{t+1}$), where I_{t+1} is the number of stages for period $t + 1$; and
- j denote the number of the state at time t ($j = 1, \ldots, I_t$), where I_t is the number of states for period t.

Variables

IL = the initial amount of owned land (acres).
IM = the initial amount of machinery owned (dollars).
IOE = the initial amount of owner's equity (dollars).
IHB = the initial amount of hog buildings owned (dollars).
L_{ti} = land owned at the end of period t in state i (acres).
PL_{ti} = land purchased at the beginning of period t in state i (acres).
SL_{ti} = land sold at the beginning of period t and state i (acres).

R_{ti} = owned land planted into 1/2 corn and 1/2 soybeans at the beginning of period t in state i (acres).

W_{ti} = owned land planted into wheat at the beginning of period t in state i (acres).

RC_{ti} = cash-rented land planted into 1/2 corn and 1/2 soybeans at period t in state i (acres).

RS_{ti} = share-rented land planted into 1/2 corn and 1/2 soybeans at period t in state i (acres).

M_{ti} = amount of machinery owned after all period-t decisions have been made in state i (dollars).

AM_{ti} = number of acres with a machinery set at the end of period t in state i (acres).

PM_{ti} = land needing machinery purchase at the beginning of period t in state i (acres).

H_{ti} = the number of units of hogs raised during period t in state i (sows).

HB_{ti} = amount of hog buildings owned after all period-t decisions have been made in state i (dollars).

PHB_{ti} = amount of hog buildings purchased at the beginning of period t in state i (dollars).

OE_{ti} = owner's equity at the beginning of period t in state i after all decisions have been made (dollars).

D_{ti} = amount of debt at the beginning of period t in state i after all decisions have been made (dollars).

OFI_{ti} = off-farm investment during period t in state i (dollars).

OFL_{ti} = amount of good field days spent on an off-farm job during period t in state i (hours). (A good field day is a day when an operator can do field work.)

SHL_{ti} = amount of summer labor hired per good field day during period t in state i (hours).

FHL_{ti} = amount of fall and spring labor hired per good field day during period t in state i (hours).

Technical Coefficients

Fixed technical coefficients are used to indicate the hours of good-field-day labor required for each of the production activities. Let

hrs = labor needed on good field days during the summer for rotation corn and soybeans (hours).

hrf = labor needed on good field days during the fall for rotation corn and soybeans (hours).

hws = labor needed on good field days during the summer for wheat (hours).

hhs = labor needed on good field days needed for hogs during the summer (hours).

hhf = labor needed on good field days for hogs during the fall (hours).

rsf = hours used in the fall divided by hours used in the summer for off-farm employment.

p_i = the probability of ending up at a terminal state for $i = 1, \ldots, I_{t+1}$, where I_{t+1} is the number of terminal nodes.

Financial Coefficients

The following are the coefficients associated with the financial aspects of this model. They include coefficients used for external credit rationing, liquidity risk, accounting, working capital and debt use, depreciation, and machinery and hog-facilities requirements. Let

dm = one minus the rate at which machinery depreciates (%).

ma = the value of machinery assets needed to farm each acre of land (dollars).

fh = the value of hog facilities needed for each sow (dollars).

db = one minus the rate at which hog facilities depreciate (%).

pl_{ti} = price of land in period t and state i (dollars per acre).

wr = working capital needed for rotation corn and soybeans grown on owned land (dollars per acre).

ww = working capital needed for wheat grown on owned land (dollars per acre).

wrs = working-capital requirement for rotation corn and soybeans

grown on land leased via a crop share (dollars per acre).

wrc_{ti} = working capital needed for rotation corn and soybeans grown on cash-rented land for period t and state i (dollars per acre).

wh_{ti} = working-capital requirement for hogs for period t in state i (dollars per sow).

tc_{ti} = transactions cost for land sale during period t in state i (dollars per acre).

pr_{ti} = after-tax profit for rotation corn and soybeans grown on owned land for period t in state i (dollars per acre).

pw_{ti} = after-tax profit for wheat grown on owned land for period t in state i (dollars per acre).

prc_{ti} = after-tax profit for cash-rented rotation corn and soybean land for period t in state i (dollars per acre).

prs_{ti} = after-tax profit for share-rented rotation corn and soybean land for period t in state i (dollars per acre).

ph_{ti} = after-tax profit for hogs in period t in state i (dollars per sow).

adm = after-tax depreciation on machinery.

adf = after-tax depreciation on hog facilities.

$rint_{ti}$ = after-tax interest rate for period t in state i paid for farm borrowing.

$rinv_{ti}$ = after-tax interest rate for period t in state i for off-farm invested capital.

$aofw$ = after-tax wage for off-farm employment (dollars per hour).

$aplf$ = after-tax wage paid to fall hired labor (dollars per hour).

$apls$ = after-tax wage paid to summer hired labor (dollars per hour).

cg_{ti} = capital gain on owned land for period t in state i (dollars per acre).

d_{ti} = the credit capacity for period t and state i in dollars (if $cg_{ti} \geq 0$, $d_{ti} = 0$, otherwise $d_{ti} = 1$). If the capital gain on land is negative, the current debt limit is equal to the last period's debt limit.

e_{ti} = the weighting for credit capacity for period t and state i (if $cg_{ti} < 0$ then $e_{ti} = 0$, otherwise e_{ti} is positive).

Right-Hand-Side Coefficients

bl = the initial amount of land owned by the decision maker (acres).

bm = the initial amount of machinery owned by the decision maker (dollars).

bhb = the initial amount of hog buildings owned by the decision maker (dollars).

be = the decision maker's beginning owner's equity (dollars).

s = the maximum amount of good field time available during the summer (hours).

f = the maximum amount of good field time available during the fall (hours).

c = the amount of withdrawals made by the family for living expenses (dollars).

$bofl$ = the maximum amount of off-farm labor allowed (hours).

$shlb$ = the maximum amount of summer hired labor (hours).

$fhlb$ = the maximum amount of fall hired labor (hours).

wb = the maximum amount of wheat grown on owned land. This is the amount of wheat base that a farmer has under government programs.

The Mathematical Model

A mathematical model of a representative Indiana corn-soybean-hog farm consistent with the above notation is described in this section. The expected utility of the decision maker is maximized subject to the following sets of constraints.

Owned-Land Usage Constraints

$$-IL - PL_{11} + SL_{11} + R_{11} + W_{11} \leq 0, \quad (2a)$$
$$-L_{t-1,j} - PL_{tt} + SL_{tt} + R_{tt} + W_{tt} \leq 0, \quad (2b)$$

for $t = 1, \ldots, T$ and $j = 1, \ldots, I_{t-1}$. Given

*It is important to get the indices correct when connecting different states of nature across time in a DSP. It is straightforward to compute the indices of the arcs emanating from a given node because at a

j, i goes from $(j-1) * I_t/I_{t-1} + 1$ to $j * I_t/I_{t-1}$.*

These constraints are used to ensure that owned land sold or used for rotation corn and soybeans or wheat is less than or equal to land previously owned or newly purchased.

Owned-Land Accounting Constraints

$$-IL - PL_{11} + SL_{11} + L_{11} = 0, \quad (3a)$$
$$-L_{t-1,j} - PL_{it} + SL_{it} + L_{it} = 0, \quad (3b)$$

for $t = 2, \ldots, T$ and $j = 1, \ldots, I_{t-1}$. Given j, i goes from $(j-1) * I_t/I_{t-1} + 1$ to $j * I_t/I_{t-1}$.

The owned-land accounting constraints are used to transfer owned land to the next period. These constraints simply require that the land owned last period plus purchases minus land sales is equal to ending owned land.

Acres-With-Machinery Accounting Constraints

$$-IL - PM_{11} + AM_{11} = 0, \quad (4a)$$
$$-dm\, AM_{t-1,j} - PM_{it} + AM_{it} = 0, \quad (4b)$$

for $t = 2, \ldots, T$ and $j = 1, \ldots, I_{t-1}$. Given j, i goes from $(j-1) * I_t/I_{t-1} + 1$ to $j * I_t/I_{t-1}$.

These constraints keep track of the machinery capacity. These constraints are necessary because machinery depreciates. Last year's machinery is only able to service a portion (one minus the machinery depreciation rate) of the land it was able to service last year.

Machinery-Assets Accounting Constraints

$$-IM - ma\, PM_{11} + M_{11} = 0, \quad (5a)$$
$$-dm\, M_{t-1,j} - ma\, PM_{it} + M_{it} = 0, \quad (5b)$$

for $t = 2, \ldots, T$ and $j = 1, \ldots, I_{t-1}$. Given j, i goes from $(j-1) * I_t/I_{t-1} + 1$ to $j * I_t/I_{t-1}$.

These constraints transfer the value of machinery from year to year. The depreciated value of last-year's machinery set plus the value of new-machinery purchases is equal to machinery transferred to the next period.

Machinery-Purchases Constraints

$$-IL + R_{11} + W_{11} + RC_{11} + RS_{11} - PM_{11} \le 0, \quad (6a)$$
$$-dm\, AM_{t-1,j} + R_{it} + W_{it} + RC_{it} + RS_{it} - PM_{it} \le 0, \quad (6b)$$

for $t = 2, \ldots, T$ and $j = 1, \ldots, I_{t-1}$. Given j, i goes from $(j-1) * I_t/I_{t-1} + 1$ to $j * I_t/I_{t-1}$.

These constraints set the machinery purchases. The depreciated machinery set from the previous year plus new purchases must be sufficient to service the acreage farmed.

Hog-Facilities-Purchases Constraints

$$-IHB + fh\, H_{11} - PHB_{11} \le 0, \quad (7a)$$
$$-db\, HB_{t-1,j} + fh\, H_{it} - PHB_{it} \le 0, \quad (7b)$$

for $t = 2, \ldots, T$ and $j = 1, \ldots, I_{t-1}$. Given j, i goes from $(j-1) * I_t/I_{t-1} + 1$ to $j * I_t/I_{t-1}$.

These constraints set the amount of hog facilities to be purchased. The depreciated amount of facilities plus new-hog-facility purchases must be greater than the number of sows the farmer intends to raise this year.

Hog-Assets Accounting Constraints

$$-IHB - PHB_{11} + HB_{11} = 0, \quad (8a)$$
$$-db\, HB_{t-1,j} - PHB_{it} + HB_{it} = 0, \quad (8b)$$

for $t = 2, \ldots, T$ and $j = 1, \ldots, I_{t-1}$. Given j, i goes from $(j-1) * I_t/I_{t-1} + 1$ to $j * I_t/I_{t-1}$.

These constraints transfer the value of hog facilities from year to year. The depreciated value of last year's hog facilities plus the value of new-hog-facility purchases is equal to hog facilities transferred to the next period.

Debt-Limit Constraints

$$-e_{it}\, OE_{11} + D_{11} \le 0, \quad (9a)$$
$$-d_{it}\, D_{t-1,j} - e_{it}\, OE_{it} + D_{it} \le 0, \quad (9b)$$

given stage, the number of arcs per node is equal across states. The computation of the indices is based on three things: the index of the arc traversed in the previous period (j), the total number of nodes in the current period (I_t), and the total number of nodes in the previous period (I_{t-1}).

for $t = 1, \ldots, T$ and $j = 1, \ldots, I_{t-1}$. Given j, i goes from $(j - 1) \cdot I_t/I_{t-1} + 1$ to $j \cdot I_t/I_{t-1}$.

These constraints represent the external credit rationing from the lender. If last year's capital gain associated with land was positive, then the amount of debt available to be borrowed is equal to a proportion of owner's equity. If, however, the capital gain associated with land is negative, then the maximum amount of credit available to this farm operator is the amount of debt held last year.

Summer Labor Constraints

$$hrs\,R_{ti} + hws\,W_{ti} + hrs\,RC_{ti} + hrs\,RS_{ti} + OFL_{ti} + hhs\,H_{ti} - SHL_{ti} \leq s, \quad (10)$$

for $t = 1, \ldots, T$ and $i = 1, \ldots, I_t$.

These constraints ensure that labor used for ten weeks during the summer is not more than or equal to that available. The amount of labor used on good field days during the summer for crops and the hog enterprises plus the amount hired out must be less than labor available from the permanent labor force plus the summer labor hired in.

Spring and Fall Labor Constraints

$$hrf\,R_{ti} + hrf\,RC_{ti} + hrf\,RS_{ti} + rsf\,OFL_{ti} + hhf\,H_{ti} - FHL_{ti} \leq f, \quad (11)$$

for $t = 1, \ldots, T$ and $i = 1, \ldots, I_t$.

These constraints require that spring and fall labor hired for 24 weeks on good field days will not exceed what is available. The amount of spring and fall labor used for crops, hogs, and off-farm employment must be less than or equal to labor available from the permanent labor force plus the fall labor hired in.

Balance-Sheet Constraints

$$pl_{ti}\,L_{ti} + HB_{ti} + M_{ti} + wr\,R_{ti} + ww\,W_{ti} + wrc_{ti}\,RC_{ti} + wrs\,RS_{ti} + wh_{ti}\,H_{ti} + OFI_{ti} - OE_{ti} - D_{ti} = 0, \quad (12)$$

for $t = 1, \ldots, T$ and $i = 1, \ldots, I_t$.

These constraints are accounting constraints which simply say that assets equal debt plus owner's equity. These constraints also set the amount of debt.

Owner's-Equity Constraints

$$IOE - tc_{11}\,SL_{11} - OE_{11} = 0, \quad (13a)$$

$$pr_{ti}\,R_{t-1,j} + pw_{ti}\,W_{t-1,j} + prc_{ti}\,RC_{t-1,j} + prs_{ti}\,RS_{t-1,j} + ph_{ti}\,H_{t-1,j} - adm\,M_{t-1,j} - adf\,HB_{t-1,j} - rint_{ti}\,D_{t-1,j} + rinv_{ti}\,OFI_{t-1,j} + aofw\,OFL_{t-1,j} - aplf\,FHL_{t-1,j} - apls\,SHL_{t-1,j} + OE_{t-1,j} + cg_{ti}\,L_{t-1,j} - tc_{ti}\,SL_{ti} - OE_{ti} = c, \quad (13b)$$

for $t = 2, \ldots, T + 1$ and $j = 1, \ldots, I_t$. Given j, i goes from $(j - 1) \cdot I_t/I_{t-1} + 1$ to $j \cdot I_t/I_{t-1}$.

These constraints calculate the owner's equity. Owner's equity is the income from both farm and nonfarm activities such as crops, hogs, off-farm employment, and off-farm investment minus expenses such as hired-labor expense, depreciation, and interest expense minus a withdrawal for family living and consumption plus last year's ending owner's equity. Included in this calculation of owner's equity is an adjustment for a change in the market value of land (cg_{ti}). The adjustment in land value is included to calculate market-value net worth.

Initial Period Bounds

$$IL = bl \quad (14a)$$

$$IM = bm \quad (14b)$$

$$IHB = bhb \quad (14c)$$

$$IOE = be \quad (14d)$$

These constraints set the initial conditions for the farm operation. Initial amounts of land, machinery, owner's equity, and hog buildings are all specified.

Other Bounds

$$OFL_{ti} \leq bofl, \text{ for } t = 1, \ldots, T \text{ and } i = 1, \ldots, I_t. \quad (15a)$$

$$SHL_{ti} \leq shlb, \text{ for } t = 1, \ldots, T \text{ and } i = 1, \ldots, I_t. \quad (15b)$$

$$FHL_{ti} \leq fhlb, \text{ for } t = 1, \ldots, T \text{ and } i = 1, \ldots, I_t. \quad (15c)$$

$$W_{ti} \leq wb, \text{ for } t = 1, \ldots, T \text{ and } i = 1, \ldots, I_t. \quad (15d)$$

These constraints place an upper limit on the off-farm employment, the hired labor,

and the wheat activities. The labor bounds are needed to limit the size of the farming operation. The wheat bound is needed when farm programs are in effect as this bound represents the amount of wheat base the farm operator has on which he is eligible for deficiency payments.

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Financial Stress on New Zealand Sheep and Beef Farms: Analysis of Change in Financial Performance Under Deregulation

Warren E. Johnston and Gerald A.G. Frengley

Abstract

A variety of government-assistance programs introduced during the 1970s and early 1980s promoted high levels of financial leverage in New Zealand agriculture. Many of the programs have since been terminated in the post-1984 period of economic liberalization, leaving behind a persistent legacy of financial stress and debt overburden. Analysis of financial changes on New Zealand sheep and beef farms provides insight on these dual effects—first that of amassing substantial financial-assistance programs over time and then removing them in a singular action. Financial measures and ratios are used to trace the changing fortunes of sheep and beef farms affected by these policies.

Key words: financial analysis, ratio analysis, subsidies, deregulation, economic policy, agricultural policy, farm debt, financial stress.

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New Zealand's social-assistance economic policies, in place for much of the post–World War II period, progressively distorted economic performance, including eventually that in the agricultural sector. New Zealand's small economy was predominantly based on agricultural exports and a highly protected import-substitution sector. The nation was relatively rich in the 1950s, but roots of decline emerged in the 1960s with a long-term fall in real commodity prices. For a time, favored status in the United Kingdom (U.K.) market insulated New Zealand producers and marketers from having to deal seriously with world markets and competition (Dickinson). The denial of market realities ceased with U.K.'s entry into the Common Market and with increased international protectionism in major markets for pastoral products (i.e., those from the dairy, sheep, and beef industries).

Declining terms of trade for New Zealand pastoral products led to a series of government-intervention policies by the conservative National Party government to expand physical production in the face of increasingly expensive energy, manufactured goods, and imported agricultural inputs. The belief was that such policies would maintain farm incomes and increase foreign-exchange earnings. Assistance measures required to maintain agricultural viability and export production included subsidizations of farm inputs, farm outputs, agricultural services, and the cost of borrowed capital. Assistance policies had side effects that led to introducing additional measures with further side effects

(Organization for Economic Cooperation and Development).[1]

Livestock numbers increased significantly as a result of these government policies,[2] but the results did not translate into substantially increased total export earnings, nor did real returns per commodity unit show significant increase (Sandrey and Reynolds). Le Heron (1989b) concluded that government policy had the unintended effects (1) of misleading farmers about market prospects for livestock products, (2) of inhibiting technological and organizational change in farming, and (3) of undermining the credibility of pastoral agriculture as a national project to strengthen farming's contribution to export earnings.

A snap election in July 1984 brought an abrupt policy shift. The Labour Party came to power with a popularly supported mandate to change the nation's economic policy from reliance on massive government assistance and intervention to one predominantly market oriented that sought more-efficient use of resources. Expensive commodity price supports and concessionary loans to commodity stabilization boards were terminated. Fertilizer subsidies were phased out, Rural Bank interest rates were progressively raised to the market rate, irrigation and water-supply subsidies were lowered, the investment tax allowances were terminated, the noxious-weeds subsidy was ended, and a cost-recovery program for product-inspection services was introduced (Reynolds, Chiao, and Robinson). Subsequent deregulation policies transferred many government-owned "crown" assets to profit-motivated state-owned enterprises; phased out land development tax concessions; introduced a flat 10-percent consumption tax on goods and services; introduced cost recovery of advisory, research, animal health, and agricultural quarantine services; reduced grants and subsidies to agricultural organizations; and removed producer board access to Reserve Bank finance (Reserve Bank of New Zealand). The rather sudden change in the economic environment due to New Zealand's economic-liberalization policies was traumatic to many agricultural production units.

This paper examines the changing financial performance of New Zealand sheep and beef farms—an important component of the pastoral production sector[3]—over a significant period of government-intervention activity and the post-economic-liberalization record. First, the agricultural sector and selected changes in the economic environment are described. Second, selected income and capital measures are examined. Third, the changing financial condition of sheep and beef farms are evaluated, followed by implications and conclusions.

Description of the Agricultural Sector

Table 1 contains selected economic information describing the agricultural sector and the pastoral subsector from 1980 to 1990. Consumer prices doubled in the first six years of the 1980s (line 1), and double-digit inflation occurred for all but one year through 1988 (line 1a).

The nominal value of total agricultural output rose sharply in 1985 (line 2a), the first year after the change in policies, in part because of a short-lived favorable movement in the exchange rate. Then agricultural output dropped in 1986 and 1987 due to the combined effects of low prices and reduced output, rising thereafter in nominal terms (line 2a). In real terms, the drop in the value of output was deeper and longer after liberalization. Even the higher forecast for 1990 is below levels

[1]Le Heron (1989a) chronicles the political goals and government interventions that constituted National Party government policies through 1984. Johnston and Frengley also provide an expanded description of the three phases of pre-1984 market-intervention policies.

[2]Pre-1984 policies consistently sought expansion of pastoral agriculture livestock numbers. Changes in stock numbers reflected farmer perceptions of optimal stocking rates, given their interpretation of economic conditions and incentives. Sheep numbers increased from 55.3 million stock units in 1976 to 70.3 million stock units in 1983 (Johnston and Frengley).

[3]In 1988, the values of pastoral agricultural outputs were: wool, $1,437 million; sheep and lambs, $698 million; beef, $982 million; and dairy products, $1,326 million (Ministry of Agriculture and Fisheries).

Table 1. Selected Economic Indicators, New Zealand, 1980–90[a]

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1. Consumer Price Index (1975–76 = 1,000)	1,705	1,973	2,289	2,589	2,700	3,016	3,426	3,998	4,410	4,622	4,898
a. Inflation from previous year (percent)	17	16	16	13	4	12	14	17	10	5	6
2. Value of Agricultural Output ($ billion)											
a. Nominal dollars	4.4	4.5	5.0	5.0	5.9	7.6	6.9	6.9	7.6	8.3	9.9
b. Real 1975–76 dollars	2.6	2.3	2.2	1.9	2.2	2.5	2.0	1.7	1.7	1.8	2.0
3. Agriculture/GDP (percent)	10.1	8.8	7.7	6.7	7.0	9.2	7.0	5.9	6.0	5.9	6.9
4. Farmland Values ($/hectare)											
a. Nominal dollars	1,395	2,008	2,941	3,128	2,957	3,085	2,793	2,462	2,390	2,508	—
b. Real 1975–76 dollars	818	1,018	1,284	1,208	1,095	1,023	815	616	542	569	—
5. Agricultural Debt ($ billion)											
a. Nominal dollars	3.5	4.2	5.2	5.8	6.8	7.4	8.0	8.5	8.0	7.8	—
b. Real 1975–76 dollars	2.1	2.1	2.3	2.2	2.5	2.5	2.3	2.1	1.8	1.7	—
6. Total Assistance to Pastoral Sector ($ million)	393	345	750	1,179	1,092	1,060	874	525	558	287	209
a. As % of pastoral sector output	15	13	24	33	30	23	23	13	12	5	3

Source: Johnston and Sandrey 1989, Sandrey and Reynolds.

[a]Annual data, some of which are calendar year, some government fiscal year ending March 31, and some production year ending June 30. Figures for 1988–90 range from provisional to forecasts.

observed during most of the early 1980s (line 2b). While agriculture continues to be the nation's major exporting sector,[4] its share of gross domestic product declined through the 1980s, again except for 1985 (line 3).

The value of capital assets was sharply decapitalized as incomes were readjusted to the new market realities. In real terms, farmland values are less than half the values attained in 1982–83, the year of peak nominal farmland value, despite a small increase in nominal value in 1989 (lines 4a and 4b). Aggregate agricultural-sector debt more than doubled in the first five years of the 1980s and continued to rise in the first several years of adjustment following the initiation of the new economic policies (line 5a). Net debt repayment is thought to have reduced nominal debt since 1987 (Johnston and Sandrey 1990). In real terms, agricultural debt increased through 1984, but has since fallen (line 5b), although less slowly than decreases in real net incomes (Table 2) or farmland values.

Government assistance to the pastoral subsector increased from $55 million in 1970 to $252 million in 1975 (Johnston and Sandrey 1989) to $1.179 billion (about one-third of the value of pastoral output) in 1983. Assistance to the subsector through the 1980s is shown in line 6 of Table 1. Increases were due primarily to the cost of the supplementary minimum price (SMP) scheme, producer board subsidies, and interest and tax concessions. Even though commodity price supports, subsidies, and concessions were terminated in calendar year 1984, substantial payments persisted through the 1984–85 production year which ended June 30, 1985 ($1.060 billion). The first apparent reduction in financial assistance, thus, appears to have occurred in 1986. Current levels of direct assistance to pastoral agriculture are significantly lower and will likely decline further.

Financial Performance of New Zealand's Sheep and Beef Farms

The annual survey of production and financial conditions of sheep and beef farms by the New Zealand Meat and Wool Boards' Economic Service (NZMWBES), covering some 22,000 sheep and beef farms in 1988, provides a consistent data base from which to evaluate changes in financial conditions for the sheep and beef subsector. The data base provides annual estimates for eight classes of sheep and beef farms, as well as an "all classes" weighted average of responses from a stratified sample of farms.[5]

Table 2 contains selected annual financial descriptors of the NZMWBES "all classes" sheep and beef farms over the past two decades. The first five columns of the table summarize aspects of the annual income and expenditure flows. Both gross farm income (col. 1) and total farm expenditures (col. 2) increased substantially over the period 1970–71 through 1984–85. Gross farm income fell by 20% in the following year (1985–86) and, despite gradual improvement, has yet to attain its 1984–85 level. A large and increasing component of farm expenditures has been interest expense (col. 3), which more than doubled during the 1980s. The combined effects of debt reduction and lower interest rates reduced interest expenses in 1989 and 1990.

Net farm income levels in NZMWBES accounts are estimated after interest payments, but before drawings, taxation payments, and principal repayments. Annual net farm income estimates in column 4 show substantial variability during the 1970s, relative stability over the first four years of the 1980s (1979–80 through 1982–83), then three years of highly variable incomes, followed by rather stable incomes for the remainder of the decade. Column 5 gives an index of real net farm incomes (1975–76 = 1000) calculated using the consumer price index (CPI) in the last column. The real net income position of sheep and beef farms fell substantially over

[4]In 1988, agricultural exports contributed about 60% of total export receipts (Sandrey and Reynolds).

[5]The 1987–88 farm survey included responses from 513 sheep and beef farms in the sample, which was selected to represent geographical, flock-size, and farm-class (types of farm) stratifications. Excluded are small farms (with less than 750 sheep or beef equivalent stock units) or mixed farms where less than 80% of farm revenue is derived from sheep or sheep plus beef cattle. All farms must be privately owned. The production year for pastoral agriculture is July 1 to June 30.

Table 2. Selected Financial Measures of the Weighted Average "All Classes" Sheep and Beef Farm, 1970–71 through 1988–90

Year	Gross Farm Income (1)	Total Farm Expenditure (2)	Interest Expense (3)	Net Farm Income (4)	Real Net Farm Income Index (5)	Total Assets (6)	Fixed Liabilities (7)	Net Worth (8)	Real Net Worth Index (9)	Consumer Price Index (CPI) (10)
		Dollars			*1975–76 = 1000*		*Dollars*		*1975–76 = 1000*	*1975–76 = 1000*
1970–71	$20,226	$14,404	$1,889	$5,822	716	$134,260	$29,998	$96,924	712	597
1971–72	22,941	15,833	2,164	7,108	800	139,882	33,461	98,858	665	650
1972–73	39,307	20,488	2,331	18,819	1,999	211,984	34,667	165,275	1,049	692
1973–74	38,198	23,940	2,692	14,258	1,373	257,430	39,568	204,935	1,180	760
1974–75	26,690	21,322	2,912	5,368	459	247,750	44,493	192,864	986	859
1975–76	40,750	27,125	3,506	13,625	1,000	290,634	49,663	227,911	1,000	1,000
1976–77	52,025	31,831	3,896	20,194	1,290	350,248	56,169	274,706	1,049	1,151
1977–78	50,928	35,943	5,070	14,985	837	379,962	68,045	295,738	988	1,313
1978–79	60,917	41,422	5,848	19,495	982	473,390	75,610	380,615	1,146	1,457
1979–80	77,667	52,896	7,438	24,771	1,066	600,783	81,483	499,377	1,285	1,705
1980–81	83,251	61,554	8,964	21,697	807	753,681	90,940	639,550	1,423	1,973
1981–82	95,586	74,185	12,137	21,401	686	858,047	112,329	718,677	1,378	2,289
1982–83	105,373	81,978	14,782	23,395	664	815,147	125,701	659,889	1,120	2,589
1983–84	104,775	86,284	16,305	18,491	503	856,356	133,709	686,803	1,117	2,700
1984–85	132,623	98,415	17,736	34,208	834	783,126	138,500	606,137	883	3,016
1985–86	106,319	90,980	21,509	15,339	329	601,927	148,273	414,104	531	3,426
1986–87	117,127	91,270	22,619	25,857	475	662,397	144,034	477,233	524	3,998
1987–88	126,178	97,691	23,862	28,487	474	633,804	141,800	447,137	445	4,410
1988–89[a]	126,800	99,100	23,000	27,700	440	626,200	133,800	452,600	430	4,622
1989–90[b]	130,300	101,400	21,300	28,900	433	673,100	131,800	499,600	448	4,898

Sources: 1970–71 to 1986–87: NZMWBES, various issues of the *New Zealand Sheep and Beef Farm Survey*. 1987–88 to 1989–90: NZMWBES (1989, 1990).

[a]Provisional.

[b]Estimate.

the decade of the 1980s. Thus, even though estimated 1989–90 gross farm income (col. 1) nearly regained its 1984–85 zenith, estimated 1989–90 real net farm income is only about half its 1984–85 level.

Columns 6 through 9 in Table 2 pertain to the capital structure of New Zealand sheep and beef farms. Total assets rose sixfold from 1970–71 through 1983–84 and then sharply declined (col. 6), while fixed liabilities, or long-term debt, increased nearly fivefold (col. 7) by 1983–84. Since 1985–86, sheep and beef farms have been working their way out of this massive burden of long-term debt, reducing it over 10% since its peak.[6]

The net-worth position of New Zealand sheep and beef farms increased through 1983–84 and then fell precipitously after 1984–85 (col. 8), reflecting the sharp fall in farm real estate and livestock values. The increase estimated for 1989–90 reflects refound stability in farm real estate values and higher livestock values. The real net worth of farm units (col. 9) fluctuated within a narrow range from 1972–73 through 1979–80, rose to its peak in 1980–81, and has fallen sharply since the 1983–84 season (col. 9). Based on the estimated 10% increase in nominal net worth between 1988–89 and 1989–90 and a greatly dampened rate of inflation (about 6%), some recovery is anticipated in 1989–90.

The financial changes affecting New Zealand sheep and beef farms over the past two decades can be recapped by comparing columns 5 and 9 in Table 2. Real net farm incomes showed weakness in the late 1970s, whereas the declines in real net worth occurred later.[7] That is, in relative terms, real net incomes declined before declines in real net worth. As incomes fell, farmers increased debt to service financial obligations, leading to a subsequent reduction in net worth. In 1989–90, both indices are less than half of their base-year levels. Average real net worth per farm is only about one-third its value at the start of the 1980s.

Analysis of Changes in Financial Performance

The changing financial condition of New Zealand's sheep and beef farms is evaluated with particular respect to economic outcomes stemming from economic-liberalization policies initiated in 1984 by the new Labour Party government. Financial ratio analysis, commonly used to chart the economic and financial performance of a firm or a homogeneous group of firms over time, is used to evaluate this massive change in economic environments, including a protracted period of double-digit inflation.[8] Lacking individual firm-level data, NZMWBES estimates for the weighted-average "all classes" sheep and beef farm are used, interpreting impacts on a synthesized farm unit. The assumption is that ratio analysis of the "all classes" farm yields insights into the overall impacts of observed changes (pre- and post-1984) on the financial viability of the sheep and beef subsector.[9]

Table 3 contains several of the financial ratios commonly identified in the financial-management literature (see, for example, Schall and Haley; Madura and Veit). *Activity or efficiency ratios* indicate

[6]Changes in land values and rural-debt outcomes resulting from a significant decapitalization of land assets since 1984 are analyzed in detail by Johnston and Sandrey (1990).

[7]The index of real net farm income weakened significantly after 1979–80, while the index of real net worth fell sharply after 1983–84.

[8]During the time period 1970–71 through 1989–90, the consumer price index rose from 597 to 4,898 (see Table 2). Thus, the index rose by 820% at an average compound rate of 11.1% per year over the twenty-year period.

[9]Many writers have contributed to knowledge about the suitability of selected financial criteria, particularly financial ratios, as measures of financial viability and stress in agriculture. Adelaja and Rose, Miller and LaDue, and Mortensen et al. used financial ratios to evaluate farm financial viability based on individual farm data. However, individual-firm data were unavailable for this study and several have emphasized the difficulty in drawing correct inferences about heterogeneous individuals or firms from sector aggregates of a population (Johnson et al., Reinsel and Joseph). Other researchers have concluded that when aggregate data must be used, multiple measures should be employed (see Penson; Lins et al.; Melichar; and Gineo et al.). The common conclusion of these many studies regarding multiple criteria reinforces the propriety of a set of financial ratios in the present analysis.

how effectively the firm is using its assets, *profitability ratios* indicate net returns on sales and assets, and *financial-leverage ratios* indicate a firm's capacity to meet its long-term and short-term obligations. Several of the ratios are routinely included in reports of the annual NZMWBES survey; additional ratios are calculated from NZMWBES data (1970–88, 1989, 1990).

Activity Ratios

The NZMWBES' capital turnover ratio (col. 1 in Table 3) reveals the rate at which an investment produces gross income. It is the ratio of gross farm income to the NZMWBES' annual estimate of total farm capital (land and buildings, truck and tractor, plant and machinery, and livestock, but not homestead or personal car). The gradual increase in gross farm incomes together with a rapid rise in capital values (mostly land) resulted in a declining ratio through 1980–81. The capital turnover ratio has subsequently nearly doubled during the 1980s, rising from a low of 11.9 in 1980–81 to the provisional estimate of 23.1 for 1988–89. Higher ratios reflect more-efficient utilization of farm capital in producing gross farm income.

Column 2 (interest expenditure divided by total farm expenditures) relates to firm efficiency in that higher proportions of interest expense not only reduce net-income prospects, but one industry expert's opinion is that it also appears to crowd out expenditures on other productive inputs, such as fertilizer, repairs and maintenance, weed control, and labor (Taylor). Interest costs ranged from 11.2% to 14.6% of total farm expenditures through the 1980–81 production year. In 1981–82, the measure rose to 16.4% and continued increasing until interest costs peaked at 24.8% of total farm expenditures in 1986–87. It has been projected to fall to 21% of total farm costs in the NZMWBES estimates for the 1989–90 production year.

Profitability Ratios

NZMWBES' return-on-capital ratio (col. 3 in Table 3) is calculated as the ratio of the economic farm surplus (net farm income + managerial salary + interest paid + rent paid − assessed managerial reward) to total farm capital. The numerator attempts to measure "... the return available to the owner-operator of a freehold, unencumbered farm after allowance has been made for the labour and management input" (NZMWBES 1988). The increase in the ratio from 1981–82 through 1987–88 reflects substantial reductions in the value of total farm capital, mostly land, although the 1984–85 estimate, influenced by the sharp increase in net income, led to a slight reversal in the trend for that year. The fall in the provisional estimate for 1988–89 and the estimate for 1989–90 reflects the partial recovery in asset values.

The two additional profitability ratios (cols. 4 and 5 in Table 3) are commonly found in the financial-analysis literature. Return on assets (ROA) is the ratio of earnings before interest and taxes (EBIT) to the value of total firm assets. It is a broad measure of the economic return to all assets employed in the firm, based on their current valuation. Return on equity (ROE) measures the return to ownership (net income) as a percentage of owner equity (net worth). ROE is often cited as the best single measure of firm profitability (Schall and Haley), but high levels of financial leverage can increase ROE simultaneously with increased firm exposure to risk (Madura and Veit). Thus, the two rates-of-return ratios provide slightly different orientations to measurements of a firm's profitability. The magnitude of the interest costs incurred on sheep and beef farms is the main contributor to higher ROAs, relative to ROEs, during the 1980s.

Financial-Leverage Ratios

Column 6 in Table 3 shows the ratio of net worth to total assets. The difference between net worth and total assets is mainly debt in the form of current and fixed liabilities. The net-worth ratio was rather stable through the mid- and late 1970s, but subsequently rose due to increases in asset values in the early 1980s. It has since fallen substantially because of increases in debt and the decapitalization of farm assets. Some recovery is evident in the most recent years.

The long-term debt to equity ratio (col. 7) measures the relationship between long-term debt and equity, with a low ratio providing greater protection to owners in the form of a larger equity cushion. This

Table 3. Selected Financial Ratios for the Weighted Average "All Classes" Sheep and Beef Farm, 1970–71 through 1989–90

	Activity Ratios		Profitability Ratios			Financial Leverage Ratios				
Year	NZMWBES' Capital Turnover Ratio (1)	Interest as Pct. of Total Farm Expend. (2)	NZMWBES' Rate of Return on Capital (3)	Rate of Return on Assets (ROA) (4)	Rate of Return on Equity (ROE) (5)	NZMWBES' Net Worth to Total Assets Ratio (6)	Long-term Debt to Equity Ratio (7)	Financial Leverage Index (ROE/ROA) (8)	Times Interest Earned (9)	Interest as Pct. of Gross Farm Income (10)
				Percentage					*Number*	*Percentage*
1970–71	17.0%	13.1%	3.7%	5.7%	6.0%	72%	31%	1.05%	4.1	9.3%
1971–72	18.4	13.7	4.6	6.6	7.2	71	34	1.09	4.3	9.4
1972–73	21.1	11.4	9.0	10.0	11.4	78	21	1.14	9.1	5.9
1973–74	16.9	11.2	5.2	6.6	7.0	80	19	1.06	6.3	7.0
1974–75	12.3	13.7	1.3	3.3	2.8	78	23	.85	2.8	10.9
1975–76	16.1	12.9	4.3	5.9	6.0	78	22	1.02	4.9	8.6
1976–77	17.1	12.2	5.4	6.9	7.4	78	20	1.07	6.2	7.5
1977–78	15.2	14.1	3.4	5.3	5.1	78	23	.96	4.0	10.0
1978–79	14.4	14.1	3.4	5.4	5.1	80	20	.94	4.3	9.6
1979–80	14.1	14.1	3.5	5.4	5.0	83	16	.93	4.3	9.6
1980–81	11.9	14.6	2.2	4.1	3.4	85	14	.83	3.4	10.8
1981–82	12.0	16.4	1.9	3.9	3.0	84	16	.77	2.8	12.7
1982–83	14.1	18.0	2.7	4.7	3.5	81	19	.74	2.6	14.0
1983–84	13.3	18.9	2.1	4.1	2.7	80	19	.66	2.1	15.6
1984–85	18.6	18.0	4.6	6.6	5.6	77	23	.85	2.9	13.4
1985–86	19.9	23.6	3.3	6.1	3.7	69	36	.61	1.7	20.2
1986–87	20.1	24.8	4.8	7.3	5.4	72	30	.74	2.1	19.3
1987–88	22.6	24.4	5.6	8.3	6.4	71	32	.77	2.2	18.9
1988–89	23.1	23.2	5.2	8.1	6.1	72	30	.75	2.2	18.1
1989–90	21.8	21.0	4.5	7.5	5.8	74	26	.77	2.4	16.3

Sources: Calculated from Table 2 or sources identified in the footnote to Table 2.

ratio was rather stable during the 1970s but fell during the early 1980s as net worth of farm units grew relatively faster than fixed liabilities. Decapitalization of land values contributed to the high ratio observed for 1985–86 when debt amounted to 36% of net worth on sheep and beef farms. The ratio fell in 1986–87 because of a modest reduction in fixed liabilities and an increase in net worth. The recent increase in asset values and further debt reduction have led to a downward trend in the ratio since 1987–88.

Column 8 in Table 3 contains the financial leverage index (ROE/ROA). With the exception of 1974–75, the financial leverage index was greater than 1.0 from 1970–71 through 1976–77, indicating that the rate of return on equity was greater than the rate of return on assets, and therefore farms were using debt capital beneficially. The index has since been below 1.0, reflecting especially high capital costs and low earnings in the sector. The index has stabilized in the three years following its lowest value in 1985–86, but it still is low relative to values observed in earlier years.

These three financial-leverage ratios measure how much debt the firm has relative to assets or equity. Two additional ratios consider the ability of the firm to service its debt. The "times interest earned" ratio is earnings before interest and taxes (EBIT) divided by interest expense (col. 9). The larger the ratio, the greater the capacity of the firm to service its annual interest expense. During the 1970s, the ratio was only once smaller than 3.7, but it has only once been larger than 3.4 since that time. The ratio of 1.7 for 1985–86 and the many ratios near 2.0 reflect the acute cash-flow problems that have plagued sheep and beef farms in the 1980s. Interest payments have been high relative to the earnings available to pay interest. Since 1985–86, the ratio has increased slightly, but the risk of liquidity problems is still high if product prices fall.

This same problem is revealed in a slightly different manner in column 10 in which annual interest expense is expressed as a proportion of gross farm income. Interest expense in the 1970s was around 10%, or less, of annual gross farm incomes, whereas by 1985–86 it increased to about 20% of the gross incomes of sheep and beef farms. Since 1985–86 it has gradually declined to around 16%, the estimate for 1989–90.

In summary, the two activity ratios indicate more-efficient utilization of farm capital following removal of assistance policies, and the proportion of total farm expenditures spent on interest rose considerably in the immediate post-1984 period. While it has since receded from the 1986–87 peak, it is still high by pre-1984 standards. Profitability ratios are influenced by asset values and interest costs. Decapitalized asset values (mainly land) affect the return on capital, giving the illusion of an increased return because total farm capital declined post-1984. The rate of return on equity also increased for similar reasons. All financial-leverage measures indicate an erosion of net worths and equities post-1984. High capital costs and low earnings are key risk attributes of the sheep and beef subsector.

These financial ratios are helpful in tracing the effects of the removal of financial assistance in 1984. Farmer investment decisions were distorted by a variety of assistance policies commencing in the mid-1960s and accelerating in the late 1970s and early 1980s. Farmers were encouraged to borrow and use financial leverage through 1984. Subsequent changes in financial assistance, commodity prices, and the interest rate show up in these ratios. Lower commodity market prices reduced net profits and liquidity. Changes in the interest rate affected debt-servicing commitments and liquidity, and altered the imputed value of assets and owner equity through the direct effect on the capitalization rate. After government assistance was withdrawn, the cost of debt servicing has become an increasing burden.

Financial Stress Among Sheep and Beef Farms

Recently some data have become available that reveal additional information about variability in economic performance within the NZMWBES' annual sample of sheep and

beef farms. Cash surplus data[10] since 1984 for all sheep and beef farms reveal that only in 1985 was the measure positive ($4,416). In 1984, cash surplus was −$7,048; 1986, −$15,732; 1987, −$7,169; and 1988, −$13,463. In 1985, there were no sheep and beef farms reporting less than 10% equity.

The percentage of all farms that were identified as "high-debt" farms[11] increased from only 6% in 1984 to 10% in 1985, 24% in 1986, falling slightly to 19% in 1987, but up to 20% in 1988. The slightly improved proportion after 1986 suggests either the exit of some heavily indebted farms or general improvements in financial conditions. Other data reveal that enforced exits are the more likely explanation. The average-net-worth ratio of these high-debt farms fell from 35% in 1984 to 27% in 1988, and the proportion of gross farm income required to service interest costs increased to 44% in 1988. About 10% of high-debt farms, equivalent to about 2% of all sheep and beef farms, had zero or negative equities in 1987 (NZMWBES 1988b).

One special evaluation of individual-firm data shows that even within a smaller, well-defined group of producers, there is substantial variability in farm performance and financial conditions. Taylor reports data for three farm-performance groups[12] for North Island Hill country farms for 1986–87. The top 15% of farms were highly profitable with a 10% return on equity capital, while the bottom 15% were clearly unsustainable as viable farm units for the longer term, having a −1.5% return. The low-performance group had nearly twice the interest cost per hectare requiring, on average, 40.5% of gross farm income to service debt.

Even within rather homogeneous farm-type groupings, extreme economic variability exists among farm units. Unfortunately, distributional information is much more difficult to come by. Some data exist only for 1984 and after, making a comprehensive analysis over a longer time period impossible. Therefore, inferences about financial conditions before and after the abrupt policy change must, at this point in time, be based on aggregate data.

Conclusions

Most forms of government financial assistance to New Zealand agriculture have now been eliminated as a result of economic-liberalization policies introduced since 1984. The analysis has revealed the severity of the financial degradation of the sheep and beef subsector caused by the attendant fall in product prices, the removal of subsidies, and the rise in interest rates. Asset values fell and debt rose.

There is evidence that high levels of financial leverage and interest expenses still significantly affect the financial health of sheep and beef farms. The effects of the distorted price signals affecting farmers' investment decisions prior to the 1984 shift in policies continue to encumber production on New Zealand's sheep and beef farms. The legacy of debt incurred through asset purchase and output expansion in the late 1970s and early 1980s remains stressful. Asset prices during that period were inflated by incomes boosted by subsidies and capitalized at interest rates which were later seen to be low.

Recovery is slow despite recent decreases in interest rates and increases in market prices for pastoral products. Some debt reduction has been possible, but despite some improvement, liquidity is still low and financial risks remain high relative to the 1970s.

[10]Cash surplus differs from net farm income in the following way. Net-farm-income estimates reported in Table 2 are after interest, but before drawings, taxation payments, and principal repayments. The cash-surplus estimate is net farm income less drawings, taxation payments, and principal repayments. A negative cash surplus results when net farm income is insufficient to service taxes and principal repayments, plus drawings for personal and family expenses. The information, based on flow-of-funds analysis, is first available for the 1983–84 production year (NZMWBES 1988a).

[11]"High-debt" farms are those whose equity was less than 50%.

[12]Three performance groups were defined based on gross income per stock unit. All three groups had roughly equal average number of stock units per farm and average equities of 62% or more, so that size and equity were not thought to be likely determinants of economic performance.

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Farm Banks in the Energy Belt: A Double Whammy?

Douglas G. Duncan, Gregory R. Gajewski, and M. Ellen Burkhart

Abstract

This paper shows that the simultaneous contractions in the farm and energy sectors did not, for the most part, hit farm banks in energy-dependent areas as hard as their nonfarm regional counterparts. Loan losses were more severe for banks in energy-dependent areas that concentrated on lending to the nonfarm sectors. However, farm banks in the "energy belt" performed less well than farm banks elsewhere. A simple regression model is used to establish an empirical link between bank nonperforming-loan levels and farm income. Financial ratio analysis is then used to review the performance of banks by type and region during 1982–88.

Key words: energy loans, agricultural loans, banks, economic sectors.

With the collapse of oil and farmland prices in the 1980s, what could be worse than depending on a bank specializing in farm lending headquartered in the energy belt? We show here that farm banks in the energy belt—Colorado, Kansas, Louisiana, Oklahoma, and Texas—generally outperformed farm banks elsewhere early in the 1980s, but they began slipping in 1983 and were markedly worse off than the rest of farm banks in the U.S. by 1986. Moreover, the rebound that began in mid-1986 for farm banks nationally has not been as strong for farm banks in the energy belt. While variations between the region's and the nation's farming fundamentals can explain some of these diverging trends, depressed local economic conditions due to collapsing oil prices also play an important role. Regression model results show a lagged relationship between farm and energy income at the county-level and bank-level nonperforming loan rates.

Farm banks in the region do, however, outperform both small and large nonfarm energy-belt banks, and the degree to which they outpace their nonfarm counterparts has widened. The outlook for the region's farm banks is cautiously optimistic as the farm economy remains on the rebound.

So what is worse than depending on a farm bank in the energy belt? Depending on the region's nonfarm banks.

Specialty Banks in the U.S. Banking System

A combination of institutional, structural, and geographic factors that link farm and energy producers to the commercial banking system accounts for the large number of farm and energy "specialty" banks in the United States. Because most farm and energy producers are small (when

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measured by assets per producer), information needed for banks' lending decisions is costly and distance-sensitive. Coincidentally, states where farm and energy producers are concentrated also have a history of restricting bank branching powers, resulting in their being served by numerous small commercial banks.

Farm banks are commercial banks with above-average concentrations of farm loans in their portfolios on a given date (Melichar 1987b; U.S. Department of Agriculture February 1989). The average of all commercial banks' farm-loan ratios has declined slightly through the 1980s to 15.7% by the end of 1988. Out of 12,961 FDIC-insured commercial banks reporting at year-end 1988, 4,337 were farm banks. They hold less than 5% of all commercial-bank assets but almost 57% of all commercial-bank-supplied farm credit (see the Appendix for data sources and definitions).

Over 55% of the farm banks are headquartered in farm-dependent counties, which are defined here as those where farm earnings as a share of total county earnings exceeded the national average in 1982. Furthermore, all but 241 farm banks were headquartered in states prohibiting or restricting branch-office networks in early 1984.

Identifying energy banks is more difficult because banks do not report their energy-loan exposure. In 1986, a confidential bank-examiner-driven survey identified 563 energy banks, defined as those with energy loans greater than 25% of capital (Smith). While some money-center banks were identified as energy banks, most energy banks are smaller institutions headquartered in a five-state area: Colorado, Kansas, Louisiana, Oklahoma, and Texas (U.S. Congress-Seidman). These states are also the dominant energy producers in the contiguous U.S. and are taken here to define the "energy belt."

The energy belt includes most of the nation's energy-dependent counties and most of the banks in energy counties. Sixty-four percent of the 490 counties that had oil and gas earnings as a share of total earnings in excess of the national average in 1982 were in the energy belt. Of the belt's 3,818 banks reporting in mid-1985, 2,245 were headquartered in the energy-dependent counties. Texas alone had 1,244 banks in energy-dependent counties. Moreover, all five energy-belt states limit or prohibit branch-office networks (Amel and Keane).

The Boom-Bust in Farming and Oil . . .

U.S. farming problems in the 1980s arose from the boom conditions of the previous decade. Rates of return on farm assets in the middle and late 1970s were high, ranging from 5.7% in 1974 to 13.3% in 1978 (Melichar 1987a). Real growth rates exceeding 10% a year in export markets for many crops were the norm throughout the 1970s. Expectations of ever-rising annual farm incomes, high inflation, and low or negative real interest rates led to a rapid increase in farmland values. Nationwide, farmland values rose over 38% in real terms between 1971 and 1980 (USDA June 1988).

Farming conditions reversed in the early 1980s as world commodity prices stagnated and export markets shrank. Tightened monetary policy, with resulting high real interest rates and disinflation, exacerbated farmers' debt-repayment problems. As expectations of future farm earnings fell, farm real estate values plummeted. By early 1988, real farmland values were down almost 6% from where they began in 1970. Rates of return to agricultural equity were negative during 1981–86, hitting a low of −14.4% in 1985.

Thanks largely to federal farm programs, the farm sector's real net income began improving in 1984. After falling almost 65% from 1978 to 1983, real net farm income climbed 228% from 1983 to 1987. However, real net farm income declined slightly in 1988 despite $14.5 billion in direct federal payments. Nonetheless, farmland values rebounded on the national level in 1988, showing their first real increase since 1980 (USDA June 1989).

The timing of the boom and initial downturn in the U.S. oil industry shows a similar pattern. The OPEC-induced near

fourfold increase in the real price of crude oil during 1973–81 set off booms in local oil-producing economies (Smith; Bluestone and Petrulis). However, domestic crude-oil prices peaked at $34.70 a barrel in March 1981 and fell almost 30% by 1986. The big shock hit in 1986, when domestic crude prices fell almost 60% in the first seven months of the year. Oil prices have recovered somewhat since then. The price of West Texas Intermediate Crude reached $21.80 on December 29, 1989, up more than $4 a barrel from the previous year.

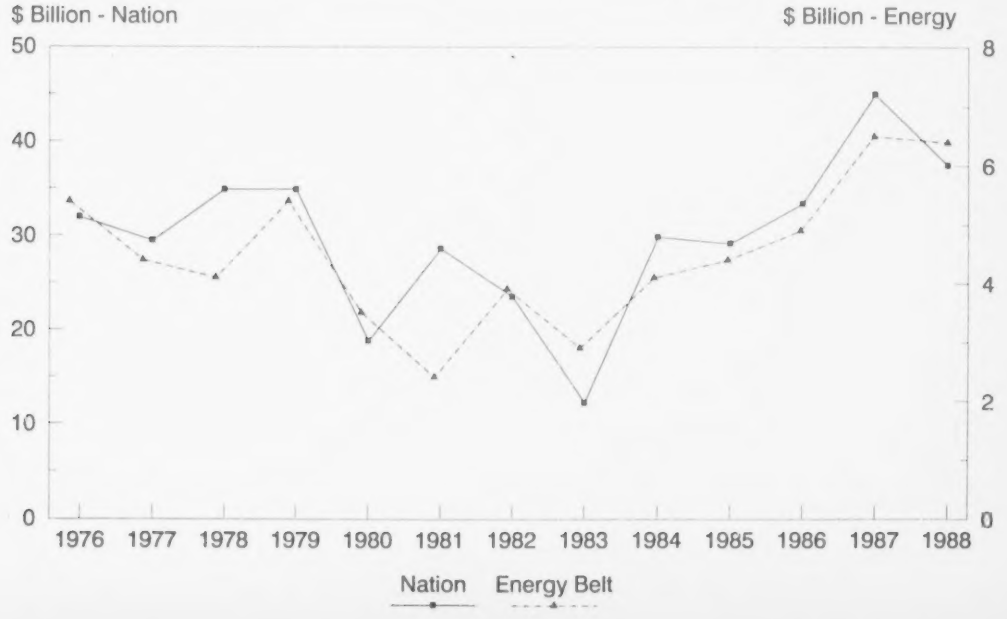
Oil- and gas-dependent economies began contracting in 1982 and fell into a depression by 1986. The number of operating oil- and gas-drilling rigs dropped below 1,000 by the end of 1986, representing a 75% decline since 1981 to pre-OPEC-era levels of activity (Brown; Carnes). In Texas, rigs selling for $3 million in 1981–82 sold for prices as low as $150,000 by 1986. Some estimate that there is an eight-year supply of developed commercial real estate available in some parts of Oklahoma and Texas. The FDIC was the third-largest employer in Midland County, Texas in 1986, a commentary on both local-banking and alternative-employment conditions (Carnes).

Farmers in the energy belt specialize in cattle, cotton, and winter-wheat production. In 1986, farm-product cash receipts in the energy belt made up only 15.5% of the U.S. total. Yet the energy belt accounted for 36% of the nation's cattle cash receipts, 34.4% of cotton cash receipts, and 34% of wheat cash receipts (USDA February 1988). Because of this specialization, farm-income trends in the region did not match national trends.

Comparing farming trends in the energy belt relative to farming trends nationally suggests that the belt's farm banks should have experienced problems earlier than farm banks elsewhere, but the region's farm banks should still have been able to outperform farm banks elsewhere at least through the mid-1980s. The percentage decline in the energy belt's real net farm income was smaller and it bottomed out earlier. Moreover, the run-up in the region's real farmland values during the 1970s was smaller and, after the 1980 peak, slower to decline through 1985 (USDA June 1988). Since 1985, however, the steeper drop in the region's farmland values would be expected to depress local farm-bank performance relative to farm banks elsewhere.

Real net farm income in the energy belt

Figure 1. Real Net Farm Income: The Nation and the Energy Belt



peaked in 1976 and bottomed out in 1981, about two years ahead of the rest of the nation (Figure 1). From peak to trough, the region's real farm income fell about 56%, compared to a national drop of almost 65%. During the recovery, the region's real farm income rose 174%, compared to a national gain of over 227% (USDA February 1988).

The region's real farmland values rose about 61% during the 1970s, roughly three-fourths of the national rise (Figure 2). During 1980–84, the energy belt's farmland values declined only slightly in real terms, propped up by generally rising farmland values in Texas. However, the declines since 1985 have been more severe; while real values were up nearly 1% nationally for the year ending February 1990, energy-belt farmland values dropped by 5% for the year and over 30% since 1985.

. . . Punished the Specialty Banks

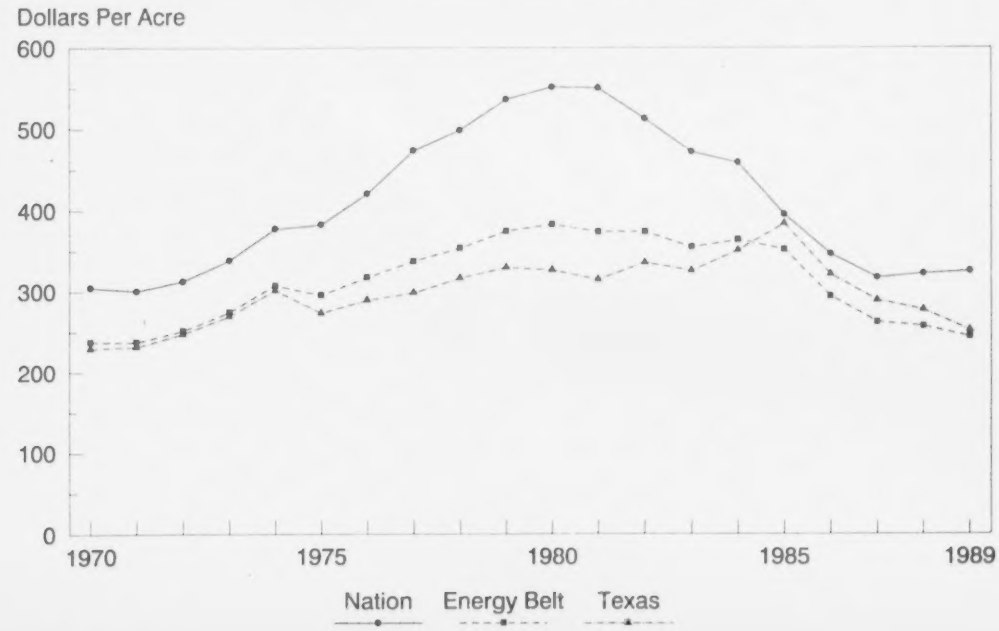
Rates of return on equity (ROE) for farm banks nationwide fell from 14% in 1982 to 5.1% in 1986. In 1986, over 30% of farm banks reported net loan charge-offs exceeding 2.5% of loans. At the typical farm bank, these loan-loss rates went through income and started eroding capital (USDA February 1989).

Nationally, farm-bank performance appears to mirror the farm sector's performance with about a two-year lag. So, while real net farm income began rising in 1984, farm banking conditions did not begin to improve until mid-1986. Nonperforming loans peaked at 4.7% of total loans in mid-1986. Likewise, farm-bank ROE bottomed at 5.1% in 1986.

The farming link to bank failures first became pronounced in 1984 when 31 farm banks failed (Gajewski May 1988). During 1984-89, over 300 farm banks failed. In 1987, 75 farm banks failed, setting a post-Depression record. Farm-bank failures have dropped since then (22 banks in 1989). Moreover, they have been falling as a proportion of total failures since 1985.

However, the failure rate for nonfarm banks in the Southwest has soared while farm-bank failures have been dropping. The concurrent decline in the energy sector would appear to be the link to nonfarm-bank performance and failures.

Figure 2. Real Farmland Values: The Nation, Energy Belt, and Texas



Smith used the results of the energy-bank survey to profile energy banks in the Kansas City Federal Reserve District plus Louisiana and Texas. Energy loans accounted for about 20% of total loans at energy banks at the end of 1985. These banks tended not to be involved in farm finance (less than 2% of their total loans). Their rate of return on assets (ROA) was well below the national average in 1985, and fell further to −0.64% in 1986.

Banking in the Energy Belt

Farm banks in the energy belt are slightly smaller and more specialized than farm banks elsewhere. Moreover, while the average farm bank outside the belt reduced its farm-loan holdings from about 38% of total loans in 1982 to about 34% in 1988, farm banks in the belt maintained an average farm-loan ratio of about 37% through the period. As a group, farm banks in the belt have increased their share of a growing volume of bank-supplied farm credit in the region, while farm banks elsewhere have become less important for supplying a steady volume of bank-supplied farm credit.

The energy-belt region's farm banks markedly outperformed farm banks elsewhere in the early 1980s, deteriorated faster than farm banks elsewhere in the mid-1980s, and have not rebounded as much as farm banks elsewhere since mid-1986. Of all the region's farming trends, only the continued weakness in the local farm real estate market is consistent with the region's farm-banking trends, perhaps explaining part of the weakness of the recent regional farm-bank rebound. While few farm banks are believed to also specialize in energy finance, regional trends in the nonfarm economy seem to be important determinants of farm banks' strength and profitability.

While exact figures on energy banks are scarce, there has been a profound deterioration in the performance of the banks in the energy belt. The ROA for all of the region's banks slipped from a healthy 1.04% in 1982 to −0.62% in 1987 before improving slightly in 1988 (to −0.59%). Over 78% of 1988's bank failures were headquartered in the belt.

Yet some banks in the energy belt managed to remain profitable in the 1980s; thus, it seems that small banks in undiversified local economies can adopt strategies to reduce risk. Participating in nonlocal loans through correspondent banks, maintaining high capitalization rates, or lowering the loan-deposit ratio by holding low-risk (i.e., Government) securities are commonly mentioned ways for banks to protect against unexpected local downturns (U.S. Congress-Clarke). Such strategies help explain how some farm banks have prospered throughout the 1980s.

Establishing the Link between Sector and Bank Performance

It is generally assumed that the performance of the farm sector is the prime determinant in the financial performance of farm banks. Various research efforts have pointed to this relationship but most stopped short of estimation. Barkley and Helander demonstrated that nonmetropolitan banks appear to facilitate, rather than generate, loan demand and resultant economic activity. They looked at aggregate economic activity without a specific focus on agriculture. An evaluation of top-performing small banks during the mid-1980s (Gup and Walter) determined that those in the Midwest and Southwest had substantially fewer loans to the agricultural and energy sectors. Duncan and Woods demonstrated that the portfolio of nonmetropolitan banks in Texas differed statistically according to the income-earning characteristics of the bank's home county. A number of articles have been produced on various performance measures of agricultural banks (e.g., Melichar 1987; Gajewski and Duncan). Each of these research efforts commented upon the relationship of bank performance to the farm or other economic sectors but omitted direct estimation. Gajewski (1990) found, using a two-step logit model, that banks specializing in farm finance or headquartered in oil- and gas-dependent counties faced higher closure probabilities in the mid-1980s. Building on this work, a simple econometric model relating bank performance to the agricultural and energy sectors is presented.

Gajewski (1990) and others show that the level of nonperforming loans relative to total loans in a bank's portfolio serves as an early indicator of loan quality problems and subsequent bank performance. It is superior to loan losses in that not all nonperforming loans turn into losses because some eventually become current or are restructured. Nonperforming loans can be carried on a bank's books for some time if they are well secured and collection procedures, not including legal action, are underway.

Classification of a particular loan as nonperforming may result from adverse factors affecting that borrower, but if there is a broad-based increase in nonperforming loans of a particular type or related to a particular production activity (e.g., agriculture or energy), it may be hypothesized that the decline in the economic performance of that sector is partly responsible.

We wish to show that bank loan-portfolio performance is related to farm and energy income in the bank's market area. As mentioned previously, classification of a bank as agricultural is dependent upon its ratio of farm loans to total loans. Aggregate bank Call Report data point to a one- to two-year lag between the bottom of real net farm income nationally and the peak of nonperforming loans among banks. Also of interest is whether there is a statistically significant difference in bank performance due to being in the energy belt given the region's dependence upon oil and gas income and its variance from national agricultural trends. Finally, there is evidence that a risk-reducing strategy of holding more securities relative to loans is related to lower nonperforming-loan levels.

To establish empirically the relationship between the performance of banks and the farm and energy sectors, the following variables are used in a regression equation:

Nonperformings (*NPFRAT*), the ratio of total nonperforming loans to total loans. This is the dependent variable;

Farm Loan Ratio (*AGLN*), the ratio of farm loans to total loans in the bank's portfolio;

Energy Belt (*BELT*), an integer variable identifying a bank's location in or out of the energy belt;

Security-to-Asset Ratio (*STP*), the ratio of total securities to total assets in the bank's portfolio;

Bank Location (*AGLNBLT*), an interaction term between *AGLN* and *BELT* to identify farm-lending emphasis in the energy belt;

Oil Income (*CHOIL*), the annual change ($000) in oil- and gas-extraction income in the county where the bank is located (1982–86); and

Farm Income (*CHAG*), the annual change ($000) in farm laborer and proprietor income in the county where the bank is located (1982–86).

The estimation of the model was carried out with 1986 bank-level data. The year 1986 represented peak levels of nonperforming loans and lagged the trough in real net farm income by about two years. Also, 1987 saw the passage of the Agricultural Credit Act mandating renegotiation of some farm loans and impacting bank behavior in that and subsequent time periods. Also, unsuppressed county-level income data were available only through 1986.

Results of the model estimation are displayed in equation (1).

$$\begin{aligned} NPFRAT = {} & 0.02749963 \\ & (37.75) \\ & + 0.000511439(AGLN) \\ & (28.46) \\ & - 0.000325891(AGLNBLT) \\ & (-9.67) \\ & + 0.0178136(BELT) \\ & (20.02) \\ & - 0.03188441(STP) \\ & (-14.63) \\ & - 0.000000159674(CHOIL84) \\ & (-12.32) \\ & - 0.0000000832757(CHAG84). \\ & (-3.21) \end{aligned} \qquad (1)$$

All variables are significant with the expected signs at the 99% confidence level (t-statistics are presented in parentheses). The F-statistic was 258.6, also significant at the 99% level. The R^2 was low at .103, but this was expected for at least two reasons: first, this was a cross-sectional analysis; and

second, it is often the case in financial-market studies that this measure is very low given the nature of the markets themselves.

Based upon the results of the estimation, we would expect the following levels for proportion of loans nonperforming: higher as the bank's proportion of farm loans is higher, but relatively lower if that bank is in the energy belt; generally higher for banks in the belt; lower as a bank holds more securities relative to loans; lower if there was an annual increase in county oil- and gas-extraction income two years previous; and lower if there was an annual increase in county farm income two years previous.

The lags on county-level farm and energy income were varied from no lag to the two-year lag presented. Only the two-year lag on each variable was significant at the 90% level or greater and had the correct sign.

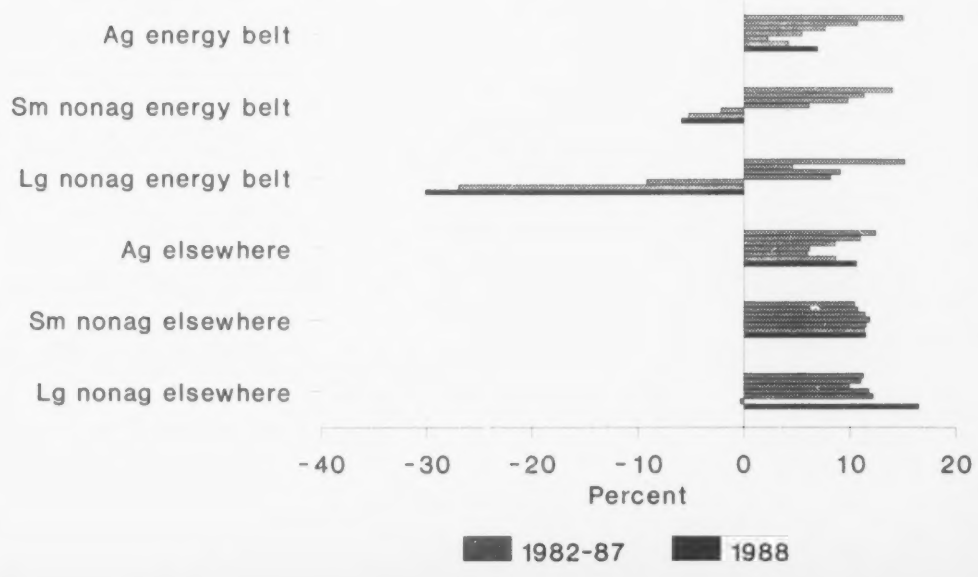
A Chow test was performed on the model to test for structural differences between banks located in and out of the energy belt (Kennedy). The resulting *F*-statistic of 82.07 was significant at the 99% level. This indicates a structural difference between banks located in the energy belt and those located elsewhere.

These empirical results appear to provide a basis for concluding that commercial banks suffered a lagged adverse impact from declines in the agricultural and energy sectors. Furthermore, the energy belt, being structurally different in the composition of both its economic and banking sectors, stood to feel the impact of the dual declines in energy and agriculture.

The Going Gets Tough for Farm Banks in the Belt: 1982–86

Despite drops in the region's real net farm income for six of the previous seven years, the farm banks in the energy belt earned an astonishing 14.99% ROE in 1982, outperforming farm banks elsewhere (Figure 3). The small nonfarm banks in the region did nearly as well with a 14.0% ROE. The large nonfarm banks in the belt, however, were the top performers in 1982, with an ROE above 15%. Perhaps strong local economies, sustained by the oil boom that had just peaked, were propelling local farm and nonfarm bank performance alike.

Figure 3. Commercial Banks' Rate of Return on Equity Capital, December 31, 1982–88



By the end of 1983, however, the energy belt's farm-bank ROE had fallen by more than four percentage points. Only large nonfarm banks recognized a larger drop in returns—their ROE slipped by more than ten percentage points. In contrast, farm banks elsewhere posted an ROE of almost 11%, down from the previous year but above the ROE of farm banks in the belt.

Generally, the energy belt's farm banks continued slipping faster than farm banks elsewhere through 1986. Farm banks in the region experienced declines in their ROEs of more than two percentage points a year from 1983 through 1986, while farm banks elsewhere experienced smaller declines for two of the three years.

Dents to profits sustained by the region's nonfarm banks became more severe compared to the region's farm banks as the decade progressed. By 1986, small nonfarm banks booked a −2.2% ROE while the region's large nonfarm banks reported a −9.2% ROE. Meanwhile, both large and small nonfarm banks elsewhere posted higher and increasing ROEs during 1984–86.

Growth in loan delinquencies and net charge-offs as percentages of total loans during the period is consistent with the notion that deteriorating profitability at all groups of banks was almost entirely due to the plummeting credit worthiness of their borrowers (Figures 4 and 5). Moreover, the trends in these credit-quality indicators confirm the trends in profitability observed for the different groups of banks. Farm banks in the energy belt deteriorated faster than farm banks elsewhere during 1984–86 but were better off than the belt's nonfarm banks by 1986.

At the end of 1984, nonperforming loans comprised about 3.3% of total loans at the belt's farm banks. The percentage of nonperforming loans at farm banks elsewhere was slightly higher in that year, but grew more slowly during 1985 and actually declined in 1986, having peaked at 4.6% in mid-1986. Nonperforming loans at the region's farm banks also peaked in mid-1986, accounting for over 5% of loans.

Credit quality deteriorated even faster at the region's nonfarm banks, especially at the larger institutions. The proportions of nonperforming loans at the region's large nonfarm banks surpassed the proportion of nonperforming loans at the local farm banks in 1986. By the end of 1986, the belt's large

Figure 4. Commercial Banks' Percentage of Loans Nonperforming, December 31, 1984–88

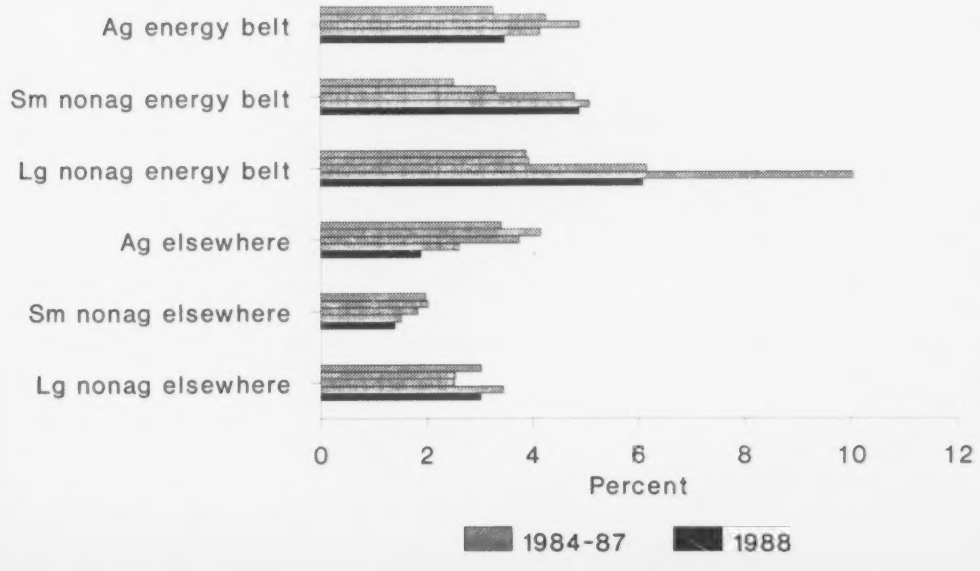
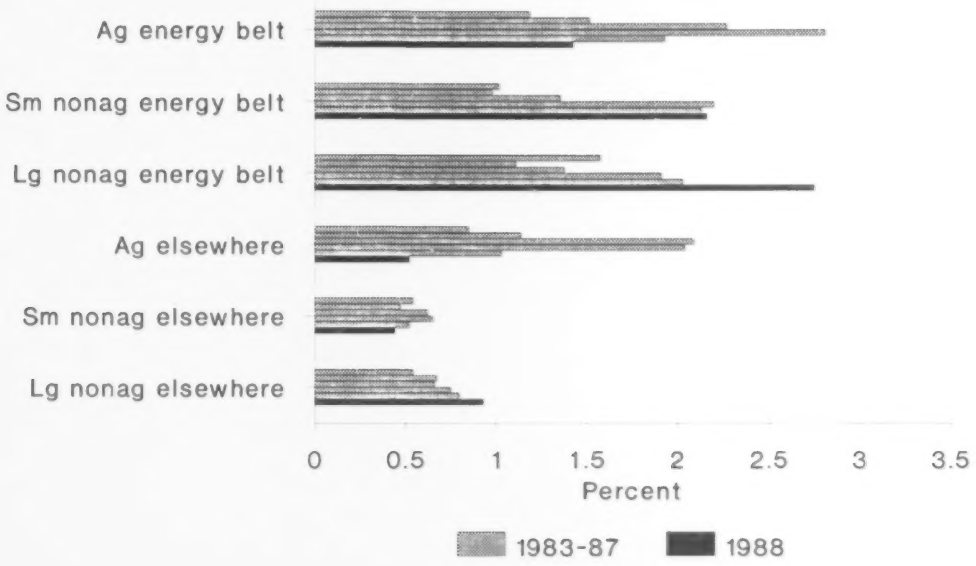


Figure 5. Commercial Banks' Net Loan Charge-Offs as a Percent of Loans, December 31, 1983–88



banks reported 6.2% of their loans as nonperforming compared to 4.9% for the local farm banks.

There are signs, however, that problems for the belt's large nonfarm banks may be moderating. Nonperforming loans may have peaked at about 10% of their loans in 1987. Nonetheless, with 6% of their loans in the nonperforming category at the end of 1988, the region's large banks were still under more stress than the belt's farm banks. FDIC-financed closures and mergers of troubled large banks in the belt likely accounted for some of the drop in the group's nonperforming-loan concentration.

Net loan charge-offs began rising for all farm banks in 1983, with energy-belt farm banks leading the way. Relative profitability between the two farm-bank groups reflected the charge-off figures. Indeed, through 1986, farm banks in the region generally experienced higher charge-off rates than any other group of banks. Charge-offs peaked at 2.8% of loans for the region's farm banks in 1986, 0.8 percentage points above the 1986 peak for farm banks elsewhere. Charge-offs at the region's large nonfarm banks reached 1.9% at the end of 1986, while the region's small nonfarm banks charged off 2.2% that year. In contrast, the small nonfarm banks outside the belt recognized 0.54% of their loans as losses in 1983, the lowest loan charge-off rate of all bank groups in that year. That figure rose to only 0.65% by 1986.

An Anemic Rebound for the Belt's Farm Banks

Nationwide, farm banks began turning the corner in mid-1986 when their percentage of nonperforming loans began to fall. While the concentration of nonperformings also peaked at the region's farm banks in mid-1986, no noticeable decline was evident until the end of 1987, when nonperformings accounted for 4.2% of loans and subsequently 3.5% in 1988. Nonperforming loans fell faster at farm banks outside the region: by the end of 1988, 1.9% of their loans were nonperforming, down almost three percentage points from the peak. Nonperformings now account for a smaller proportion of total loans at farm banks elsewhere than they did in 1984, but nonperformings at the belt's farm banks remain about one-fourth of a percentage point higher than in 1984.

Following the trend in nonperforming loans,

ROEs at the region's farm banks bottomed out in 1986 at 2.3%, rebounding to 6.9% by the end of 1988. Farm banks elsewhere, however, showed a stronger rebound with an ROE of 10.6% in 1988, up from 1986's ROE of 6.0%.

The weak rebound at the region's farm banks looks more favorable given that the returns to both big and small nonfarm banks in the belt continued deteriorating from 1985 onward. At the end of 1988, small nonfarm banks in the belt recorded a −5.9% ROE. Deterioration was worst at the region's large nonfarm banks; they recognized a −30.1% ROE.

Farm banks in the belt continue to aggressively address their loan-quality problems by charging-off at a faster pace than the region's nonfarm banks. Net loan charge-offs at the region's farm banks, at 1.4% of loans at the end of 1988, remain almost triple the rate at farm banks elsewhere.

While charge-offs in 1987 at the region's nonfarm banks were high by historical norms, they were low relative to the growing volume of nonperforming loans. Large nonfarm banks in the region charged off 2% of their loans in 1987, but also reported 10% of their loans as nonperforming. In contrast, the region's farm banks had about the same charge-off rate and reported only 4.2% of loans as nonperforming.

This changed in 1988 as the large nonfarm banks in the belt reduced their nonperformings to 6% of loans and pushed up their charge-offs to 2.75% of loans. Delinquency and charge-off rates both dropped for farm banks in the region.

Bank Failures and Banks Vulnerable to Failure

Both the number of farm banks in the belt with nonperforming loans greater than capital and farm-bank failures dropped in 1988 (Figures 6 and 7). Twenty farm banks in the belt failed in 1988, down from thirty-five in 1987. That is also a drop in the regional farm-bank failure rate from 3.21% annually to 1.81%. Moreover, the decline in the number of local farm banks with nonperformings greater than capital, a leading indicator of failure, is a promising sign that farm banks in the region may fail at a slower rate in the future. At the end of

Figure 6. Commercial Banks with Nonperforming Loans Greater than Capital, 1985–88

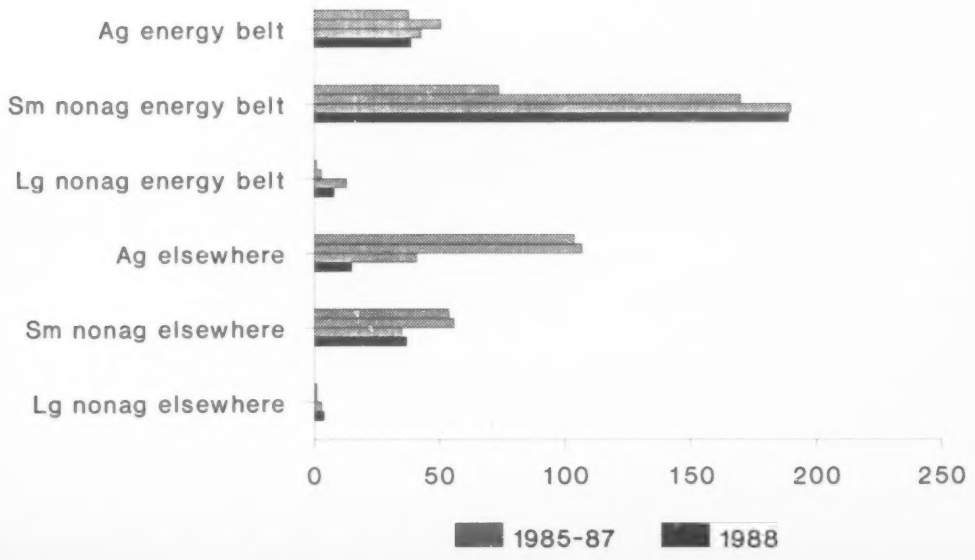
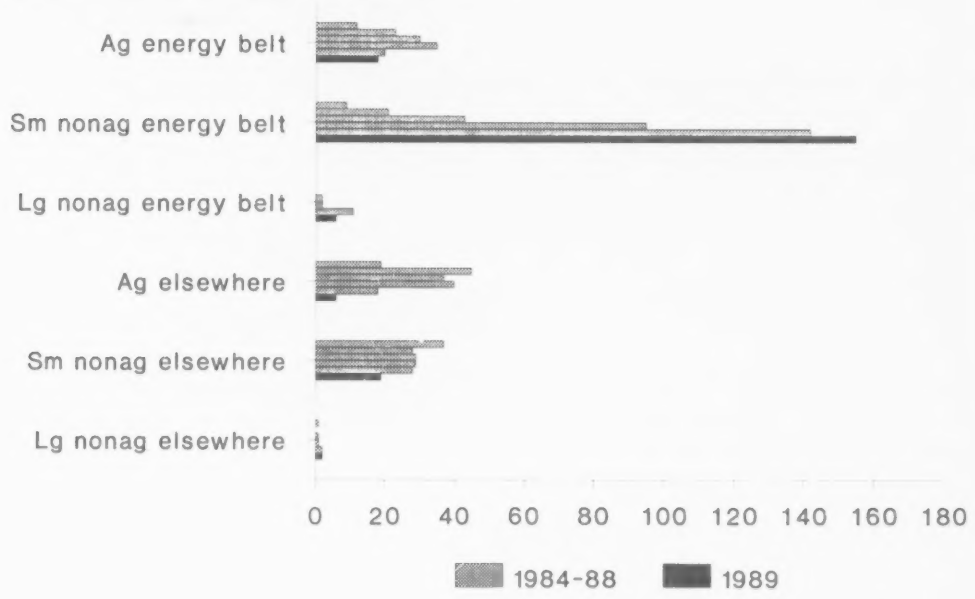


Figure 7. Commercial Bank Failures, 1984–89



1988, thirty-nine farm banks reported this vulnerable condition, down from fifty-one in 1986.

While the number of vulnerable nonfarm banks in the region mushroomed from 1985 to 1987, some stabilization was evident in 1988. In 1985, 74 small nonfarm banks in the belt reported nonperforming loans greater than capital. Yet, despite the failure of 280 small nonfarm banks in the region from 1986 to 1988, 189 small nonfarm banks were vulnerable at the end of 1988. Eight large nonfarm banks reported nonperformings exceeding capital in 1988, slightly over 17% of the region's large banks, up from 1 bank in 1985. Total vulnerable banks in the belt represented 81% of vulnerable banks nationally in 1988.

Such high proportions of vulnerable nonfarm banks in the region may explain why these banking groups did not move as quickly to deal with their nonperforming and weak loans. Banks with little capital relative to sour loans would naturally be reluctant to take large losses. Reporting these losses could push them into reporting a book-value insolvent position. Acknowledging insolvency is inviting the regulatory authorities in for a closure decision which could spark runs by technically uninsured depositors (i.e., those with deposits greater than $100,000). Indeed, in Texas alone, the FDIC in 1988 merged and granted financial assistance to two giant multibank holding corporations that owned ninety-nine of the region's banks with over $45 billion in cumulative assets.

Outlook for the Belt's Farm Banks: Cautious Optimism

Although weaker than the rebound for farm banks outside the belt, the upswing in local farm-bank profitability coupled with declining delinquencies and the declining number of vulnerable farm banks augurs well for the future of farm banking in the energy belt. The turnaround at the region's farm banks is more noteworthy given the conditions of their local nonfarm counterparts and the continued decline in the region's farm real estate values relative to the rest of the nation. Any optimism for farm banks in the belt, however, must be tempered by two factors: the potential of continued volatility in world energy markets, and the potential for declines in farm income through the impact of recurrent drought or the reduction of federal support.

Widespread droughts have an uneven effect on farm banks because they have an uneven effect on farmers. Farmers with irrigation or adequate local rainfall may realize unexpectedly high incomes because the prices of farm products usually rise. However, farmers with yields cut by the drought lose income and are more likely to default or delay payment on loans.

The potential for reduction in federal support of farm incomes is significant as deficit-reduction alternatives are discussed. The federal contribution to recent farm income levels has been substantial.

The outlook for the region's farm banks also hinges on the outlook for the region's nonfarm economy. The importance of the region's nonfarm economy is clear since the local farm banks' performance does not regularly follow the region's farming trends, and seems to be influenced by the oil price cycle. Oil prices have recovered somewhat since 1987, yet the region's nonfarm economy has a long way to go before recouping the mid-1980s' losses.

Appendix: Data and Definitions

Data

Data on commercial-bank performance are from the Report of Income and Report of Condition files maintained at the Board of Governors of the Federal Reserve System. Unless otherwise stated, data are from the December reports. Commercial banks are defined as domestically chartered, FDIC-insured commercial banks reporting nonzero loans, deposits, and assets on the date specified. The identities of failed banks were supplied by the Office of Research, FDIC and are available in the annual reports of the FDIC. Except for the farm-loan ratio used to define farm banks, all financial ratios are weighted by bank size.

Data on the farm- or energy-dependency of a bank's headquarters county are from the Bureau of Economic Analysis (BEA), U.S. Department of Commerce. The county characteristics examined here are the percentage of total county earnings from the agricultural sector and the percentage of total county earnings from the oil-and-gas sector. Agriculture is defined at the two-digit Standard Industrial Code (SIC) level and excludes forestry and fisheries. The oil-and-gas data are defined at the three-digit SIC level as the crude-petroleum-and-natural-gas sector. All BEA estimates used here are unsuppressed data by place of employment.

Data on the performance of the agricultural sector are from the publications cited, occasionally supplemented with USDA-ERS unpublished updates and revisions.

Definitions

Small/large banks: Banks referred to as small reported total assets less than $500 million on the date specified. Large banks are those reporting total assets of $500 million or more. The small-bank group is an ideal peer group for comparisons to farm banks because virtually all farm banks have less than $500 million in assets.

Farm loans: The sum of loans to finance agricultural production and other loans to farmers plus real estate loans secured by farmland.

Rate of return on equity (ROE): Net after-tax income as a percentage of equity capital.

Rate of return on assets (ROA): Net after-tax income as a percentage of total assets.

Nonperforming loans: Loans past due 90 days or more and still accruing interest, plus loans in nonaccrual status.

Net loan charge-offs: Gross loan charge-offs less recoveries.

Renegotiated (restructured) loans: Loans and leases that have been restructured and are in compliance with their modified terms. They are loans whose terms have been modified because of a deterioration in the financial position of the borrower to provide for a reduction in either interest or principal. Prior to June 30, 1986, such loans were reported as "renegotiated 'troubled' loans."

Banks with nonperformings greater than capital: Considered by many analysts to be

the best single indicator of a bank's chances of failure (Melichar, 1987a). Capital is defined as in Melichar and includes equity capital plus allowance for loan and lease losses plus minority interest in consolidated subsidiaries plus mandatory convertible debt plus subordinated notes and debentures. This definition most closely resembles the regulatory definition of primary and secondary capital allowed by Call Report data for comparisons over time.

Bank failures: Banks declared insolvent and closed by their chartering authority plus banks receiving open bank assistance from the FDIC. Bank failures that did not file their Call Report for the June preceding the year they failed are excluded.

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Calculation of Loan Losses: Restructuring Versus Foreclosure: A Comment

Ananth Rao and Glenn Pederson

Lins and Robison provide a useful discussion of the issues involved in the calculation of loan losses when considering the alternatives of restructuring and foreclosure. Our comment focuses on two major issues discussed by Lins and Robison: the assessment of cash flows on restructured loans and what discount rate to use when making the net present value (NPV) calculations.

We start with the premise that the restructure process is a bilateral arrangement between the borrower and the lender. Therefore, any analysis of the relative costs of restructuring would need to consider borrower concessions since they would substantially influence the extent of gain (or loss) from restructure alternatives. Although not explicitly mentioned in the Agricultural Credit Act of 1987, borrower concessions of cash, stock, and real assets are often required by the lender to reduce the outstanding loan balance or interest rate sufficiently to demonstrate viability of the restructured loan. Restructuring is what the borrower and lender do jointly and is, as a practical matter, not confined to the unilateral actions taken by the lender. In difficult restructuring cases, the lender would not knowingly make an interest-rate or monetary concession, or reschedule, reamortize, or modify the terms of a nonperforming loan without sufficient borrower concessions to justify the restructuring as a sound credit decision.

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Restructure analysis generally involves identification of cash inflows and outflows associated with restructuring. The outflow items are the total principal investment (under the original loan terms), the present interest balance (which includes accrued interest on the original loan plus all other cash expenses advanced on the loan to date), charge-off of principal and/or interest by the Farm Credit System (if any), and all other restructure cost items. The inflow items include concessions made by the borrower under the restructure plan (cash, stock, and property, or other considerations at net realizable value) plus the present value of payments to be made under the restructured loan agreement. Cost of restructure/compromise is equal to the difference between the present value of total outflows and the present value of total inflows, when each item is discounted at the appropriate rate. This procedure conforms with the principle of full costs and returns (Robison and Burghardt).

The restructure analysis of Lins and Robison does not take borrower concessions into account. They omit Land Bank stock and other concessions of the borrower in their restructure analysis. The procedure they present clearly overstates the net cost of restructuring. To show this, we reworked the Lins and Robison example and included the recapture of stock ($15,790) held by the borrower. In the case where the farmer quits farming and pays off the loan balance three years after the loan was restructured, the loan loss amounts to $107,627 ($325,787–$218,160). Since the restructured loan balance is reduced by stock, the present value of payments is also reduced to $218,160. The adjusted loan loss

is higher than the $84,450 loss which would have occurred if the restructured loan continued to perform for twenty years (Table 1, Col. 5). Under the interest write-down alternative, the lender's actual losses are $21,184 ($325,787–$304,603). Here, the adjusted present value of payments is $304,603. The adjusted loan loss is lower than the $65,025 loss that would have occurred if the restructured loan continued to perform for twenty-six years (Table 1, Col. 4).

This comparison indicates that if the borrower's stock is not subtracted from the outstanding loan before working out the net present value calculations, the restructure costs from an interest-rate write-down are less than the comparable figure reported by Lins and Robison ($22,399). Thus, even though the decision to restructure is unchanged, there is an understatement of the benefits from restructuring and a corresponding overstatement of the net present cost. This example takes into account only the recapture of stock. Our experience with loan restructuring activity at the Farm Credit Banks of St. Paul shows that borrowers offered the lender cash and other concessions in addition to stock in several cases. In situations where these concessions occurred, they represented about 40 percent of the pre-restructured debt.

Based on the Lins and Robison example, the restructured loan will now be fully repaid by the end of year 26 with the interest write-down alternative (Table 1, Col. 1). The restructured debt will be repaid before the end of year 20 if the principal write-down occurs (Col. 3). Assuming the borrower has a constant $28,500 cash available for debt repayment each year, there is a potential trade-off for the lender to (1) reduce the loan life below thirty years in both the alternatives, or (2) increase the post-restructure interest rate in the case of the interest write-down alternative and/or decrease the write-down of principal. The second alternative would allow the lender to hold expected loan losses constant by adjusting the post-restructure interest rate upward while maintaining a longer loan maturity. The restructure alternative illustrated by Lins and Robison (i.e., reamortization over thirty years and write-down of the interest rate to 7.35%) may not be the best alternative for the lender to pursue.

Table 1. Revised Loan-Loss Computation for Cost of Restructure Analysis

End of Year	Scheduled Payment (1)	Principal Balance		NPV of Loan Loss (if loan is paid off at year-end)	
		Interest Write-Down (2)	Principal Write-Down (3)	Interest Write-Down (4)	Principal Write-Down (5)
0		$325,787[a]	$205,552[b]		
1	$28,500	321,232	202,746	$7,849	$115,564
2	28,500	316,343	199,589	14,882	111,374
3	28,500	311,094	196,038	21,184	107,627
4	28,500	305,459	192,043	26,818	104,281
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
18	28,500	165,625	40,961	62,253	84,680
19	28,500	149,298	17,581	62,979	84,515
20	19,779[c]	N/A	0	N/A	84,450
20	28,500	131,771		63,573	0
.	.	.		.	
.	.	.		.	
.	.	.		.	
24	28,500	47,800		64,859	
25	28,500	22,813		64,974	
26	24,490[d]	0		65,025	

[a]Original loan amount outstanding, $341,577 less $15,790 (stock).

[b]Principal write-down of $221,342 less $15,790 (stock).

[c]Last scheduled payment associated with the principal write-down alternative.

[d]Last scheduled payment associated with the interest write-down alternative.

The second point of our comment is that we find the discussion by Lins and Robison concerning selection of an appropriate discount rate to be somewhat ambiguous. They respond to the question posed in the paper by suggesting that alternative discount rates would be correct depending on what the lender intends to do with the funds generated and how (if) risks are to be incorporated. We see this problem of an appropriate discount rate as a potentially complex issue and provide an example which indicates that economists are not in agreement on this point.

Lins and Robison suggest using the "rate paid on bonds retired, plus overhead expenses eliminated" in the Farm Credit System (FCS) case to discount the costs of foreclosure if the proceeds are to be used to retire bonds. However, it is not clear from the discussion which rate on bonds is applicable (these obligations are historically at different interest rates and maturities). Additionally, Lins and Robison do not identify which overhead expense items would be eliminated or indicate how they might be allocated and incorporated into the proposed discount rate. Given the alternative of writing new loans with the funds generated by foreclosure, Lins and Robison would require the lender to use the expected internal rate of return on new loans. We contrast this with the restructure analysis proposed by Duft and Willett which recommends that the discount rate be set at the average rate of return on the lender's performing loan portfolio. These are fundamentally different rates of return. The rate proposed by Lins and Robison is theoretically more defensible since it would incorporate expected changes in the rate of loan default. However, the proposal of an expected rate of return raises additional questions about how that rate is to be determined. This is potentially a complex problem to solve both theoretically and practically since it involves estimation of expected loan losses. Fischer and Pederson have provided a discussion of one methodology which is useful in modeling those losses in the Federal Land Bank.

Subsequently, Lins and Robison indicate that the discount rate for foreclosure and restructure is comparable unless the lender uses risk-adjusted discount rates and the risks differ between these two alternatives. Although this issue is not addressed in the paper, it is difficult to see how the risks could be equivalent or how an assessment of the present costs of restructure alternatives and foreclosure could avoid using differential discount rates. For example (using the approach of Lins and Robison), assume that a nonaccrual loan is liquidated through foreclosure. If the funds are to be used to make a new loan, then the expected rate of return on accruing loans is the opportunity cost and, therefore, the appropriate discount rate. However, if the nonaccrual loan is restructured, the post-restructure loan may still be considered at higher risk of default than the accruing loan portfolio. This is the rationale behind requiring the FCS to initially carry these loans as "restructured-cash flag." We suggest that the appropriate discount rate on the restructured loan is the expected rate earned on an accruing loan plus a premium for default associated with the probability that a loan restructured in period t will not perform in period $t + 1$ times the opportunity cost of having written an accruing loan.

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Calculation of Loan Losses: Restructuring Versus Foreclosure: A Reply

David A. Lins and Lindon J. Robison

Rao and Pederson focus their comments on the assessment of cash flows for restructured loans and the discount rate to use when making net present value (NPV) calculations. As stated in our article, "losses from structuring are typically measured as the difference between the current balance of principal and accrued interest compared with the net present value of cash flows arising from the terms of the restructured loan." So, in calculating losses from loan restructuring, we have no disagreement with including concessions made by the borrowers. Moreover, our proposed methodology does not preclude such inclusion. Thus, if the restructured loan includes concessions by the borrower in the form of applying existing stock against the loan balance, obviously they should be considered even though we did make explicit mention of this detail in our paper. Rao and Pederson make an important point by emphasizing the role of stock concessions by borrowers when calculating loan losses from restructuring.

According to the 1987 Farm Credit Act, the Farm Credit System (FCS) must apply stock against the principal balance if the compromise includes a write-off of principal. For example, if a borrower owes $300,000 of principal plus $30,000 of accrued interest, then the entire $30,000 of accrued interest could be written off without necessarily applying stock against the loan balance. However, for each dollar of principal written off, the law does require a dollar-for-dollar application of the stock against the principal. So, in our example of a principal write-down, Rao and Pederson are correct in asserting that the loan amount should have been lowered by the amount of stock because the write-down exceeds the amount of accrued interest.

If the restructuring entails an interest rate write-down, the application of stock against the loan balance is a negotiable item. Our contacts with FCS personnel suggested that stock is applied against loan balances in about 50% of the cases involving an interest write-down. In addition, interest write-downs appear to be far more common than principal write-downs in most Farm Credit districts. Thus, our choice of not applying stock against the loan balance in the case of an interest write-down appears reasonable.

Also in their comment, Rao and Pederson question our choice of a discount rate. A present value model involves a comparison between two investments: the one already held (a defender) and the one under consideration (a challenger). In our problem, two defenders are considered: a restructured loan and a foreclosed loan. The challenger in this case is the "next-best" use of the funds from either foreclosing or restructuring the loan. If the next-best use of the investment's funds is to liquidate bonds, the bond rate is the appropriate discount rate. The question is: should the interest rate on these bonds be the market rate, the rate at the time they were sold, or an average rate? Since changes in the bond rate have already affected the value of the firm and are in a sense "sunk," the market rate of return on bonds plus administrative cost savings, we believe, is the appropriate rate. But what if the funds are to be used to finance a new loan? Then, of course, the next-best use of

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the funds is the internal rate of return available on new loans.

This criterion governing the selection of the discount rate was stated in our paper: "If those funds will be used to retire bonds, the appropriate discount rate is the rate paid on the bonds retired, plus any overhead expenses eliminated. If the lender intends to use the funds to make new loans, the appropriate discount rate is the internal rate of return expected on the new loans."

Rao and Pederson, however, find our discussion surrounding the selection of a discount rate "somewhat ambiguous." They further state that our proposed discount rate is "theoretically more defensible" than that proposed by Duft and Willett. Then they suggest that "the appropriate discount rate on the restructured loan is the expected rate earned on an accruing loan plus a premium for default associated with the probability that a loan restructured in period t will not perform in period $t + 1$ times the opportunity cost of having written an accruing loan." We disagree. This cannot be the appropriate measure of the discount rate since an existing loan cannot be the "next-best use of additional funds."

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